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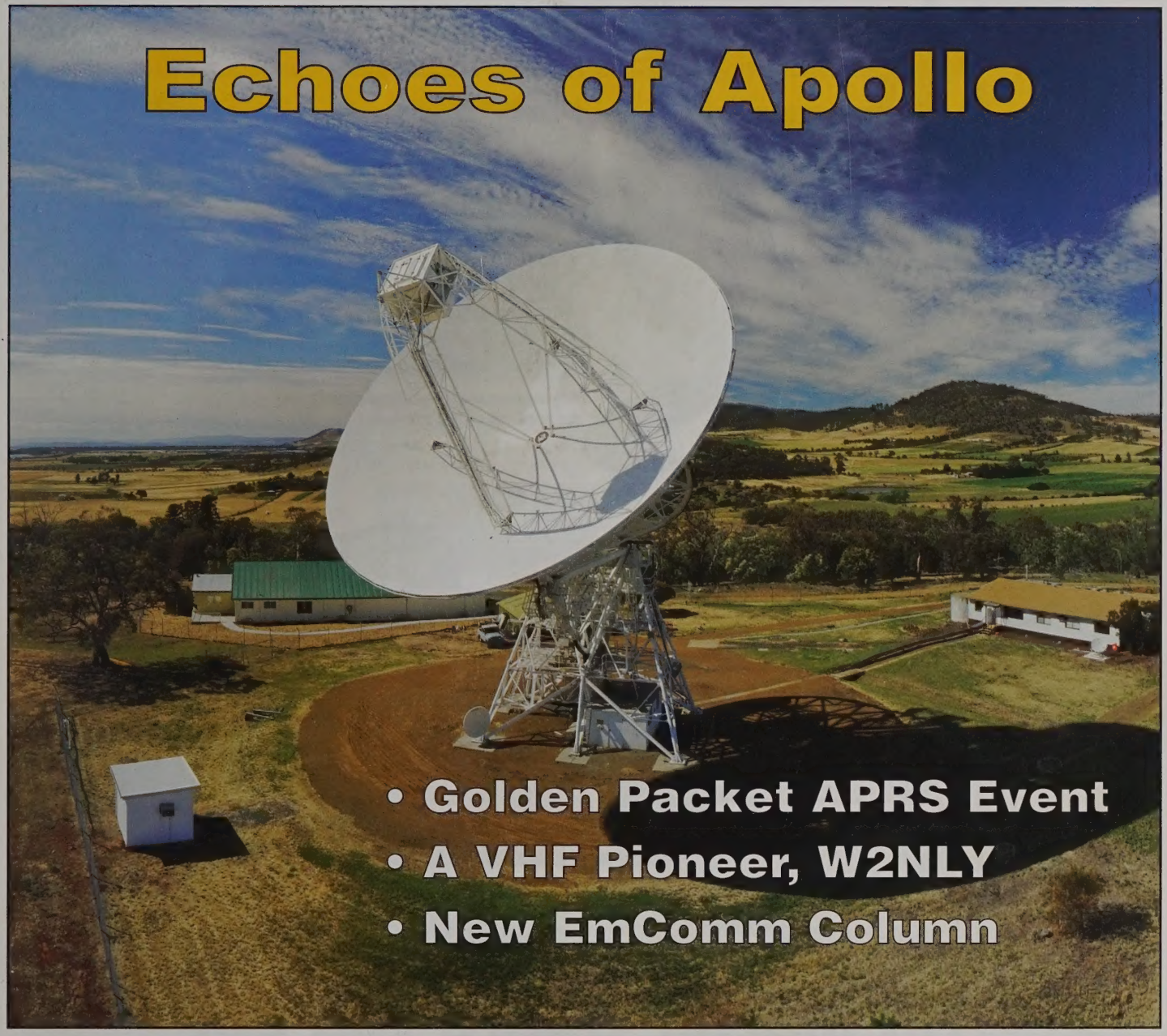

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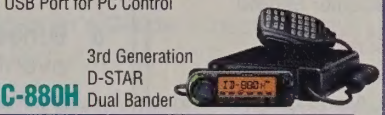

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contents

Spring 2009
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FEATURES

COLUMNS

DEPARTMENTS

On The Cover: This University of Tasmania owned 26-meter dish was built in 1965 by NASA and installed at the Orroral Valley Tracking Station near Canberra. It was part of NASA's worldwide tracking and data network, operated by the Space Projects Branch of the Australian Department of Science. It typically maintained contact with a dozen satellites per day. It was involved in the Orbiting Solar Observatory (OSO), the joint US-USSR manned Apollo-Soyuz mission, and the Space Shuttle program, as well as tracking the re-entry of Spacelab over Australia. When the tracking station was closed by a reorganization, the dish became surplus. NASA then donated it to the university. It was moved to Mount Pleasant between July 1985 and February 1986, and officially opened on May 13, 1986.
Photo courtesy Dr. Jim Lovell, the University of Tasmania.

CQ VHF Ham Radio Above 50 MHz

LINE OF SIGHT

A Message from the Editor

On the "EVE" of Something Big

During the late morning of March 25, 2009—at 1038 UTC, to be precise—members of the German amateur satellite organization (AMSAT-DL) began transmitting signals on the Bochum 20-meter dish. Those signals would take a 100-million km (45.46-million mile) round trip to Venus. The total time for the round trip was five minutes. It was at the end of those five minutes when the AMSAT-DL hams began to hear the echoes of their transmissions. Thus, history was made—the first ever Earth-Venus-Earth (EVE) reflection of an amateur radio transmitted signal. They were able to replicate their experiment the next day for several hours, often sending the Morse code characters for the letters "hi," which harkened back to the "hi" message transmitted by the first amateur radio satellite, OSCAR 1.

In actuality, the goal of reflecting signals off the surface of Venus was an intermediate goal of AMSAT-DL. Its long-term goal is to orbit a satellite around Mars. This effort to bounce a signal off Venus was a test of their equipment, which, it seems, worked quite well.

As you can see, the title for this editorial is "On the 'EVE' of Something Big." Indeed, we might be on the eve of a resurgence of space exploration. NASA is well into its plans to return to the Moon and explore Mars. Japan has indicated the possibility of robotic exploration of the Moon by 2020. Therefore, it seems a natural for the folks at AMSAT-DL to want to be a part of the action with their plans to orbit Mars with an amateur radio satellite.

How else can amateur radio become involved? Already some members of the moon-net reflector have suggested an EVE QSO between AMSAT-DL and another big dish. Thus far, however, no one has stepped forward to accept the challenge. When it happens, it will be written about within the pages of this magazine, as well as reported in my "VHF Plus" column in *CQ* magazine.

What else can amateur radio operators do? Part of the answer can be found in the article entitled "Echoes of Apollo," which can be found beginning on page 6 in this issue. In the article Pat Barthelow, AA6EG, announces events to honor the 40th anniversary of Apollo 11th's lunar landing. The principal on-the-air event, World Moon Bounce Day, will begin June 27, at 0200 UTC. Pat has lined up several big and not-so-big dishes from around the world for participation in EME contacts. As of this writing some, such as the Mt. Pleasant 26-meter dish in Tasmania and the Stanford 45-meter SRI dish, are tentative in their commitment because of possible last-minute scheduling conflicts. Others—such as the CAMRAS Group's 25-meter Dwingeloo dish in Holland, the new 22-meter dish at Eaglin Space Center at Morehead State University in Kentucky, the 4.6-meter Smiley dish at the Pisgah Astronomical Research Institute in North Carolina, and the Deep Space Exploration Society dish locate on Table Mountain in Colorado—are committed to being on the air on World Moon Bounce Day. For the latest information, please check the EOA website: <http://www.echoesofapollo.com>.

What else can hams do? Involve young people, which seems like my continual drum beat. The EOA can be a huge educational event for young people. Having them witness echoed signals from the Moon is exciting for all the participants. Even more exciting, however, is for one of those young ppeople to speak into a microphone and 2.5 seconds later hear the return.

For example, in 2007 in celebration of the UK's Jodrell Bank Telescope's 50th anniversary, a group of children read and listened to their poetry being bounced off the Moon. The video, available on YouTube and linked to the EOA website (see: http://echoesofapollo.com/moon-bounce/), shows the children reading and the parents taking pictures of their children. One of the children later remarked that it was a lifetime event for her.

Other educational opportunities exist. For example, the Grote Reber Museum is located on the site of the Tasmanian 26-meter dish. Reber is the father of radio astronomy. Perhaps the museum could hold open hours during the time of the event or in relationship to the event. Perhaps other educational events can also be planned. If you are working on such an event, then please report it to the EOA website.

As you will see from the EOA website, there are a lot of activities happening in celebration of the anniversary. Several of the activities are not amateur radio related. Even so, the huge potential for worldwide publicity for amateur radio certainly exists—and it is certainly possible that we are indeed "On the EVE of Something Big."

Someone has to Write about This Stuff

With this issue Mark Morrison, WA2VVA, contributes his eighth installment of his well-written and well-researched articles on our history. For the past two years he has focused on files and audio tapes that his father stored during his years as a ham radio operator.

For this issue, however, Mark goes away from the file cabinets and the reels of tapes and into the home of one of the remaining pioneers of his father's day who is still alive. Jim Kmosko, W2NLY, graciously consented to two interviews with Mark. What you read beginning on page 26 is the result of those interviews.

While Mark has spent two years writing his great stories, there are so many more stories to be told. For example, so little is known about Grote Reber's amateur radio activities. Another pioneer on the other end of the KH6UK-W6NLZ circuit was John Chambers, W6NLZ. Perhaps someone can take up the challenge to write about pioneers such as Reber and Chambers.

Another New Column: EmComm

With this issue we introduce Mitch Gill, NA7US. Actually, Mitch does a great job of introducing himself beginning on page 60. Mitch will cover emergency communications from a VHF perspective. Topics he will cover in the not too distant future include interoperability, pre-positioning of assets, and EOCs. If you have an area of EmComm that you would like him to cover, please contact him via his e-mail address: <na7us@arrl.net>.

And Finally . . .

It has been my pleasure to serve as your Editor for the past seven years. As I begin my eighth year at the helm, I am looking forward to many more great things to emerge from the wonderful world of VHF and above. As I stated above regarding EVE, perhaps we are on the EVE of great things, not only for EVE and EME, but also for the entire VHF and above spectrum.

Until next time…73 de Joe, N6CL

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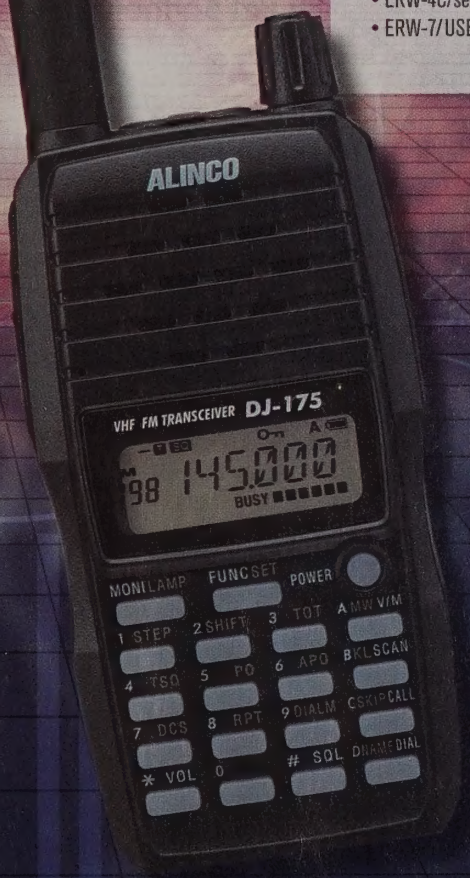

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Echoes of Apollo

A World Space Party and an Amateur Radio EME Event

It was on July 20, 1969 that the world witnessed the Apollo astronauts set foot on the moon's surface. For those of us alive at the time, it was one of those flashbulb events—events for which you remember where you were and what you were doing at the time. Now, 40 years later, amateur radio operators around the world are being encouraged to participate in events to celebrate the anniversary. Here AA6EG gives comprehensive coverage to the amateur radio related plans for the celebration.

By Pat Barthelow,* AA6EG

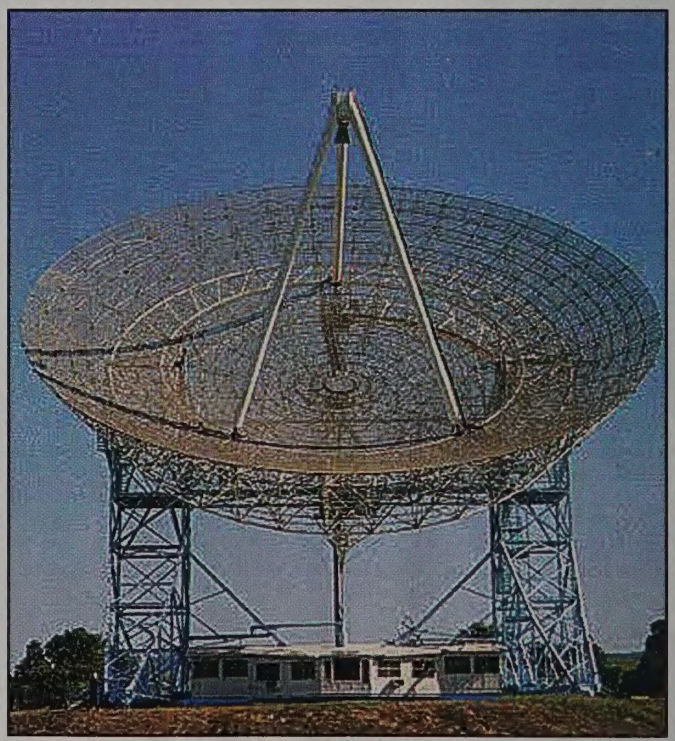
In December 2008 I discovered a website that was a gathering place of members of the Overseas Telecommunications Veterans Association (OTVA), an Australian group with a high percentage of hams as its members. In visiting with them I discovered that some of them were thinking about commemorating, celebrating, the 40th anniversary of the Apollo 11 moon landing. In time plans were formulated for such commemorations, and as it turns out events have been taking place throughout the year and will culminate on July 20th, the anniversary date of the moon landing.

During the course of my visiting with these members, I discovered that some of them had active roles in the Apollo 11, and subsequent, moon landing missions, and had some exceedingly interesting behind-the-scenes stories to tell about that historic space mission and that era of telecommunications.

We discussed the Australian-produced movie *The Dish*, which I had only recently seen and enjoyed. I was amazed at the skill of the movie makers in bringing those of us who had lived that era back to the time, with proper electronic equipment, with "Nixie tubes," and familiar names and models of the era.

I wondered how accurately *The Dish* portrayed the reality of the events, set at the famous Parkes Radio Telescope. I wondered whether the scenes inside the huge 65-meter Parkes dish control room were shot inside the real Parkes. It turns out that the interior scenes were very accurate, shot in a high fidelity set, meticulously recreating the real Parkes control room at the time of the Apollo missions. Particularly prominent in the Parkes control room, both real and the set, were the huge gusset plates and associated nuts and bolts that fortunately held the structure together through the severe windstorm experienced during Apollo 11.

In the movie a lot of creative license was taken with the plot relative to historic events, but I am sure it will hit resonant chords with radio amateurs and professionals who have been around big dishes. Another dish, at Honeysuckle Creek, was a critical player early on during the moon walk, but was not mentioned in the movie. Robert Brand, an OTVA member and now



The 45-meter SRI dish near Stanford University is scheduled to be available during the EOA on-the-air event. (Photo courtesy of SRI International)

**599 DX Drive, Marina, CA 93933*
e-mail: <Patrick.Barthelow@apolloeme.com>

The new 22-meter dish at the Eaglin Space Center at Morehead State University in Kentucky will be used for the EOA on-the-air event. (Photo courtesy of Morehead State University and Jeff Kruth, WA3ZKR)

The re-emergent CAMRAS Group's 25-meter Dwingeloo dish in Holland will be on the air. (Photo courtesy of the CAMRAS Group)

EOA (Echoes of Apollo) Events Manager, filled in with information and had especially interesting true tales of, for example, from time to time finding deadly Australian Brown snakes inside the Parkes control room among the warm racks of equipment.

I thought that the Australians might like to add to their planned anniversary celebrations "revisits" to the moon, only this time via radio waves. That idea went over very well, and is being refined with an EOA team mustered, evolving now into a planned, multifaceted, worldwide special event. The event includes EME, science outreach activities, special event stations, and local, national, and international public interaction and participation.

An Invitation to the Ham Radio Community

I would like to invite the worldwide amateur radio community to join the Echoes of Apollo (EOA) event, which is planned to be the world's biggest "Space Party," in June in any capacity suitable to your interests, whether it be EME, HF special event station setup, or IT connectivity (networking—we want to distribute activities via the internet). We are planning for Friday, June 26, at 1700 PDST (or 0200 UTC June 27), which is predicted to be a time and date with good EME conditions between West Coast USA and southwest Australia, where some of the large dishes that may participate are located. This sked is subject to change, and additional skeds are in the works. Keep

The radio telescope atop the Dwingeloo dish. (Photo courtesy of the CAMRAS Group)

informed about amateur radio exact schedules, stations participating, and activities by visiting the EOA website: <http://www.echoesofapollo.com>.

Incidentally, there appears to be a blockbuster movie coming out in June with a moon theme, appropriately called *Moon*, directed by Duncan Jones and Starring Sam Rockwell. Nathan Parker Films is involved, and I have contacted Nathan, who wants to experience moonbounce. I am arranging for Nathan to "guest op" at an EME station sometime, perhaps during EOA.

Our prime objective in the EME activity of EOA is to have fun and work with 23-cm SSB EME communications between Australian EME stations and the world EME community during the month of June, and in some cases to July 20. There are a number of players in the EME community who are capable of SSB communications on this band, especially if we access the large Australian dishes we are seeking. We don't want to leave out anyone in the EME community, so please, you are welcome to

The 4.6-meter "Smiley" dish at the Pisgah Astronomical Research Institute in North Carolina is scheduled to be activated during the EOA activity weekend. (Photo courtesy of PARI)

The Jamesburg Dish An Update

My experience in EME is unusual, as I have mainly seen/heard/operated EME as a result of my founding and working with the restoration and operation of the Jamesburg Earth Station. I mustered a very talented technical team that did most of the hands-on technical work and dish restoration. For the most part, they are members of the 50 MHz and Up group of central California. The current status and future of Jamesburg is in the hands of its private owner, who wants to sell the beautiful 160-acre property, including the Earth Station. The owner leaves no options off the table, including leasing the Earth Station, or the original plan, demolition of the dish and development of the property. Someone needs to find a part-time "killer application" for Jamesburg that can pay the freight on the site, and also allow educational and science outreach opportunities in which amateur radio could play a key role. The very recent news of Venus "Echoes" experiment done by AMSAT-DL begs the creation of funding for further experiments of that sort, possibly using Jamesburg, if Jamesburg ever re-emerges into operation.

(For more on the Jamesburg Earth Station and its role in EME, see the articles by AA6EG in the Spring and Summer 2007 issues of CQ VHF—ed.)

Joe Martin, K5SO, of Espanola, New Mexico, plans to use his 28-foot EME dish for the EOA party. (Photo courtesy of K5SO)

The Deep Space Exploration Society (DSES) will turn on its 20-meter dish located on Table Mountain, Colorado. (Photo courtesy of DSES)

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Doug McArthur, VK3UM, will use his famous 28-foot Kennedy dish in Australia for the EOA event. (Photo courtesy of VK3UM)

Chris Skeer, VK5MC, will use his 9.8-meter dish during the EOA party. (Photo courtesy of VK5MC)

join in with other EME modes and frequencies. Coordinate with me at: <Patrick.Barthelow@echoesofapollo.com>. There will be EOA special event QSL cards created and issued for EOA contacts from HF to microwave.

Our proposalthe latest news is that our request for EME use of the 45-meter SRI Dish above Stanford University has been granted, on a not-to-interfere basis with their professional work, and we are clear for late June. Immense thanks are due to SRI International for allowing us to use the Big Dish for this EOA event.

I come from "old school" 1960s-era ham radio, with, to this day, a special love of DX, HF CW signals coming over the pole from Europe, and various forms of contesting, with about 40 amateur radio Field Day weekends in the log with the same core team, the Chews Ridge group, K6MI. Today, though, our EOA team doesn't think that particular HF mode, by itself, has the panache for attracting new blood to ham radio and using ham radio as a medium of science outreach. Our EOA team thinks EME has the exotic challenge and mystery to warrant use in demonstrations having science outreach within their objectives and can attract new blood to ham radio.

Some of the dishes committed to the EOA event include the new 22-meter dish at the incredible Eaglin Space Center, Morehead State University in Kentucky, directed by Dr, Ben Malphrus with lead engineer Jeff Kruth, WA3ZKR.

We also have the seasoned and re-emergent, CAMRAS Group's 25-meter Dwingeloo dish in Holland. In Colorado, the Deep Space Exploration Society is tuning its 20-meter dish on Table mountain for 23-cm EME, among a host of other projects. In North Carolina, we are preparing "Smiley," the 4.6-meter dish of the Massive Pisgah Astronomical Research Center (PARI), for use.

Well-known EMEer Joe Martin, K5SO, of Espanola, New Mexico, plans to use his effective 28-foot EME dish for the EOA party. "Down under" we have Doug, VK3UM, the seasoned EME master, with his famous 28-foot Kennedy Dish, scorched and singed (but okay), by the way, by the brutal and deadly Australian bush fires that raged through his property and through large areas of Victoria, Australia.

Another big dish that is being set up and groomed for EME is the University of Tasmania's 26-meter dish at Mt. Pleasant, near Hobart, Tasmania, and managed by Dr. Jim Lovell (no relation to the astronaut, except for the passion for space). Jim's big dish needs to be groomed for EME, and his professional staff, including ham radio ops on board, will be doing the EME preparations. Local Tasmanian hams are encouraged to help Dr. Lovell prepare the giant dish. Please get in contact with Dr. Lovell, at: <Jim.lovell@utas.edu.au>. Also, Chris Skeer, VK5MC, will participate, adding his magnificent 10-meter dish.

Press-time deadlines and constraints have limited my comprehensive coverage of other leaders in the world EME community. Updated information is always being added to the EOA website. Please visit the site regularly for the updates, including future EME projects. Finally, please come join us and enjoy the party off the moon. ■

Internet References and EME Resources

Echoes of Apollo: <http://www.echoesofapollo.com>
Stanford/SRI Dish: <http://www.sri.com/esd/dish/index.html>
Morehead State University Space Sciences: <http://ssc.moreheadstate.edu/>
University of Tasmania, Mt. Pleasant: <http://www-ra.phys.utas.edu.au/observatories/mount-pleasant.html>
CAMRAS Dwingeloo Dish: <http://www.camras.nl>
Apollo 11, the *rest* of the story: <http://www.parkes.atnf.csiro.au/news_events/apollo11/>
DSES Dish: <http://www.deep-space.org>
OK1DFC Large Dish, Czech Republic: <http://www.ok1dfc.com/>
Overseas Telecommunications Veterans Association: <http://www.otva.com/>
"432 and Above Newsletter" by Al Katz, K2UYH: <http://www.nitehawk.com/rasmit/em70cm.html>
Movie Information: *Moon*, Directed by Duncan Jones: <http://www.imdb.com/title/tt1182345/>
Movie Information: *The Dish*: <http://www.imdb.com/title/tt0205873/>
Jamesburg EME: <http://www.jamesburgdish.org>

The Appalachian Trail Golden Packet APRS Event

From KI4SGU's announcement in the February 2009 "VHF Plus" column in *CQ* magazine about a 2-meter simplex group focused on the Appalachian Trail came a query from WB4APR concerning the possibility of traversing the trail with a single packet. Here are the exciting results of their dialog.

By Jorge de la Torre, KI4SGU,* with Bob Bruninga, WB4APR†

Growing up in the '70s I would often pass time in the long hot Louisiana summers reading radio and electronics magazines, mixed with a steady supply of *National Geographic* and *Boys Life*. As a young Cuban immigrant living on the south shore of Lake Pontchartrain, there was little I could do to equal those adventures and exploits, either in money or access to faraway mountains or glaciers.

Now, however, I still often dream the dream of exploring new and exotic DX destinations, but I'm now fully integrated into American culture with all the normal pressures of mortgage, family, and job, all of which keep me firmly planted in antenna-restricted suburbia.

Occasionally, while waiting in the infamous Atlanta commuter traffic, I entertain myself by planning radio adventures for my fellow commuters and myself, albeit with nearby radio contacts, or working LX (see sidebar), as the group calls it. During one such planning QSO, the idea of activating the whole of the Appalachian Trail, all 2100 miles of it, with radios started to formulate in my head.

After doing a little internet research, I learned that the trail had originally been the vision of another urban dreamer, Benton MacKaye, in 1921. He imagined a trail that would offer the urban dweller an escape. The Appalachian Trail opened as a continuous trail in 1937. It was designated as the first National Scenic Trail by the National Trails System Act of 1968. I also learned in my research that many other amateur radio operators enjoyed the trail and worked simplex and repeaters along its length. Most notably on the repeater efforts is Beau Bushor, N1MJD. His list is available at <http://www.fred.net/kathy/at/hamguide.html>. To date, however, no one had ever passed traffic for the entire length of the Appalachian Trail.

These radios are APRS user friendly. (Photo courtesy of WB4APR)

In my further internet searches I did find amateur radio operators on mountains—lots of them. They all seemed to have a real interest in the hobby. I learned about two similar groups out west, "Operation On-Target" (http://www.ontargetbsa.org/) and the Colorado-14er Ham Event (http://www.14er.org/). Yet these events are held out in the Rockies, with the staggering height of those peaks, giving them the advantage of commanding overlooks. Nevertheless, I don't live out west. I live with the gentler and more modest peaks of the Smoky Mountains and the Appalachians. Still, I wondered if it would be possible to communicate more than just a few dozen miles with an HT.

In the late fall of 2008, after a few experimental trials on the more humble metropolitan peaks of Atlanta (Kennesaw, Lost, Stone, and Sawnee), I learned that 80–100-mile contacts with a 5-watt HT and an Arrow antenna were not only possible, but easy to arrange with other

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like-minded amateur radio operators. Therefore, in order to help with the scheduling I decided to start an internet group by the name of Peak-2-Peak. More on our group can be found at: <http://groups.yahoo.com/group/peak-2-peak>.

During the first week of the group's existence, in early 2009, many members joined, sharing their stories much like my own, wanting to escape the confines of their normal lives and comfortable ham shacks. Many of the early members were predictably my repeater buddies from right here in the metro Atlanta area. However, I knew if I was ever going to realize the dream of full north-south message transit, I would need many more hams to embrace this idea. I would need them from faraway places such as Vermont and Maryland to help me. OK, Vermont and Maryland are not exactly Descheo or Borneo, but hey, this is VHF, so work with me here.

A few weeks later you could have knocked me over with a feather, when one morning while checking my e-mail and processing the membership requests for the Peak-2-Peak group, I got a message from none other than APRS (Automatic Position Reporting System) legend Bob Bruninga, WB4APR. After he joined the group, he was most helpful and enthusiastic. He also shared the dream that I had.

In fact, he did one better. When he read about my idea in a brief press release I had sent to *CQ* magazine (see the February 2009 issue, page 89), he commented that he had thought of something similar many years back, but in his version he would pass APRS packets (what a surprise), and only one packet for the entire length of the trail—One Golden Packet. In a blizzard of e-mails between us and a few others we planned and refined the idea. The "Appalachian Trail Golden Packet APRS Event" was (re)born.

The Appalachian Trail Golden Packet APRS Event would be a yearly event where we would marshal enough amateur radio communication teams on mountain peaks in the eastern USA to be able to communicate APRS messages from beginning to end of the Appalachian Trail on a weekend. The Appalachian Trail is normally considered a 2100-mile walk, but the RF path is more on the order of only 1200 miles, and using 60- to 80-mile links, we should be able to do this in fewer than 20 hops.

This Appalachian Trail Golden Packet APRS event is scheduled to take place in July to coincide with the Annual Appalachian Trail Festival at Castleton State College in Rutland, Vermont. For more information on that event, see: <http://www.vermont2009.org/>. To sign up for this APRS event as a volunteer anywhere in the 14 states along the trail, see the web page: <http://www.aprs.org/at-golden-packet.html> for the latest formation, or send a message to the Yahoo group <http://groups.yahoo.com/group/peak-2-peak/>. Also remember that APRS was never just about tracking; it was originally messaging! For more information about this and other misunderstandings, see the article posted at this website: <http://www.aprs.org/APRS-tactical. html>.

To pull this event off right, preliminary

Google Earth Graphics layout of line-of-sight accessible points from Clingman's Dome. (Graphic courtesy of WB4APR)

The author working peak-to-peak during a recent trek in the Appalachian Mountains. (KI4SGU photo)

link tests are also highly encouraged during Field Day, or sooner if possible, so pack up the kids and the radios in the van and head for the hills.

Now for the Technical Stuff

Although the normal APRS network provides full coverage along the Appalachian Trail on the USA APRS channel of 144.39 MHz, this channel is too heavily shared by local coverage and support and any one link is limited to about two hops. Therefore, we will use a special uncongested frequency just for this event.

Frequency. Finding a clear frequency for the one-day event is a significant problem. I hope we might include the ATV crowd and the use of their 144.37 FM voice and balloon data frequency. I'm proposing it here to see if there are any conflicts.

For voice coordination, the APRS FM simplex channel 445.925 will be used, as well as the simplex frequency 146.520 MHz, as specified by K4JWM for wilderness-protocol-style contacts (see: <http://k4jwm.wikidot.com/wilderness-protocol>). Also the idea of "voice alert" on the normal 144.390 channel is yet another tool (see: <http://aprs.org/VoiceAlert3.html>).

Significant APRS Characteristics for this Event. The following will be used:

1. AT stations will operate with a traceable path LINK7-7 for messages.
2. AT stations will use the shorter nontraceable HOP7-7 for positions.
3. Stations should be able to see seven adjacent nodes in both directions.
4. As the links will be linear links, there will be few dupes.
5. Packets will be regenerated at the midway point for seven more hops.
6. D700/D710s can act as portable digis for the ultimate in simplicity.
7. Phase-I: To get the end-to-end Golden packets successfully.
8. Phase-II: After Golden packets then station messages are welcome.
9. Phase-III: After station messages then other trail hikers are welcome.
10. Phase-IV: Beyond that, other stations off the trail are welcome.

Station and Route Planning. For maximum range between hops, the path from Georgia to Maine will zigzag between mountain ranges rather than trying to shoot straight along the Appalachian Trail ridge. The height-above-average-terrain (HAAT) between the Appalachian Trail peaks (but along the trail ridge) is only a few hundred feet, which limits line-of-sight distances to only about 20 miles. However, zigzagging from the Appalachian Trail peaks to adjacent mountain ranges and back will take advantage of *thousands* of feet difference in HAATs across valleys and should be able to get much farther per hop.

Author with his son Nick on Sawnee Mountain, Georgia. (KI4SGU photo)

Setting up these off Appalachian Trail sites is knowledge that cannot easily be derived from just looking at the Appalachian Trail maps alone, and requires input from local sources who know the highest peaks ±50 miles from the Appalachian Trail. Those sources are probably the VHF contesters, repeater owners, and local clubs.

Packet Paths. The message packets (Golden Packets) will use the traceable TEMP7-7 paths for accountability. Position packets generally do not need to be traced. They will use the very short (but nontraceable) HOPn-N paths for all position reports. This will drastically reduce the length of each position packet.

Message Formats. For the official long-haul Golden Packets we will use only BULLETINS (BLNx) NORTHbound and only ANNOUNCEMENTS (BLN#) SOUTHbound. This eliminates ACKS and QRM yet lets everyone read the mail. Adjacent station-to-station messages for setup and coordination may use conventional APRS messaging on the normal 144.390 APRS channel.

Retransmission. Regenerating a DX message packet is the key to the long-haul success of this operation, since any given packet can only go seven hops before it is exhausted. For planning purposes, we suggest having seven full-function APRS packet stations at the key regional boundaries for easy re-entry and typing of the messages. This simplifies all of the stations in between, which can then be simple digipeaters only. A mobile D700 (or portable KPC-3 TNC digi) parked at the right place may suffice. I think we can do it in 14 hops using APRS, and we need help figuring out all the teams and details at many of these 14 sites.

The group needs your VHF and hiking experience at these locations to help with site planning. Of course, we will need volunteers at all the sites, and no one has yet tcome forward with local knowledge at some of these sites. This is an excellent opportunity to get your local clubs involved.

South to North. We have identified the following sites and to date we have the following commitments:

Springer Mountain, KI4SGU, KE4NOB, and others from the Atlanta area

Whiteside Mountain, KI4DSO team

What Does Working LX Mean?

Simply put, working LX is essentially the opposite of working DX. The "L" in LX usually means local. This practice evolved with some of the Atlanta hams traveling away for business or vacations and then making contacts back to friends in Atlanta. I was introduced to the group by Bill, KB4KFT, and Arnold, KC4ZUA. They had been doing it for some time in a very informal way. My contribution to the group was helping it grow by better organizing and promoting the "LxPeditions." These events are a lot fun and seem to motivate folks to build or buy new antennas or other portable gadgets to improve their performance. They are neither radio contests nor science projects, but borrow many of the fun aspects of both.

Typically the LxPeditions are 250 to 300 miles out from Atlanta, on 75 meters, and scheduled for late evenings during the week. They usually include, and grew out of experiments with, near-vertical incident skywaves (NVIS). We sometimes also schedule the events at *lunch* time (yet another meaning for the "L" in LX) and on 10 meters. We have even had a few on 2 meters, and one was on the satellites.

Working LX while mobile is permitted, as is working them from your home QTH, but the real the fun comes in setting up a mini Field Day station, and then comparing notes on antenna deployment techniques and portable battery packs, etc. Setting up these stations is harder than it would seem, and makes one very good at setting up and tearing down one's mobile station.

These events usually last only one or two hours. Most of the guys who participate know each from the metro 2-meter repeaters and area clubs. It is also a fun way to teach the younger hams about HF and NVIS, because most events are Tech friendly and stay to the Tech portions of the bands.

Although working LX is mainly a regional concept, the idea could easily be adopted by clubs or groups around the country. Also, the term "LX" has caught on and seems popular with all who hear it. More information can be found at the group's home page: <http://groups.yahoo.com/group/LxPeditionsAtlanta/>.

Be forewarned: The group will not accept any request for membership unless the requester has already worked at least one LX event. This is the only rule that the group has as a prerequisite for membership.

LxPeditions Atlanta group is at the origins of the Peak-2-Peak group, having taught me some the lessons of getting hams excited to get on the radio with different and unique event ideas.

Sugarloaf Mountain, team needed

Pilot Mountain, team needed

Clingmans Dome, western path, team needed

Roanoke Mountain, one can see parking lots on Google Earth! team needed

Horse Haven Mountain, team needed

Apple Orchard (AO), a popular VHF site 146.685/t100

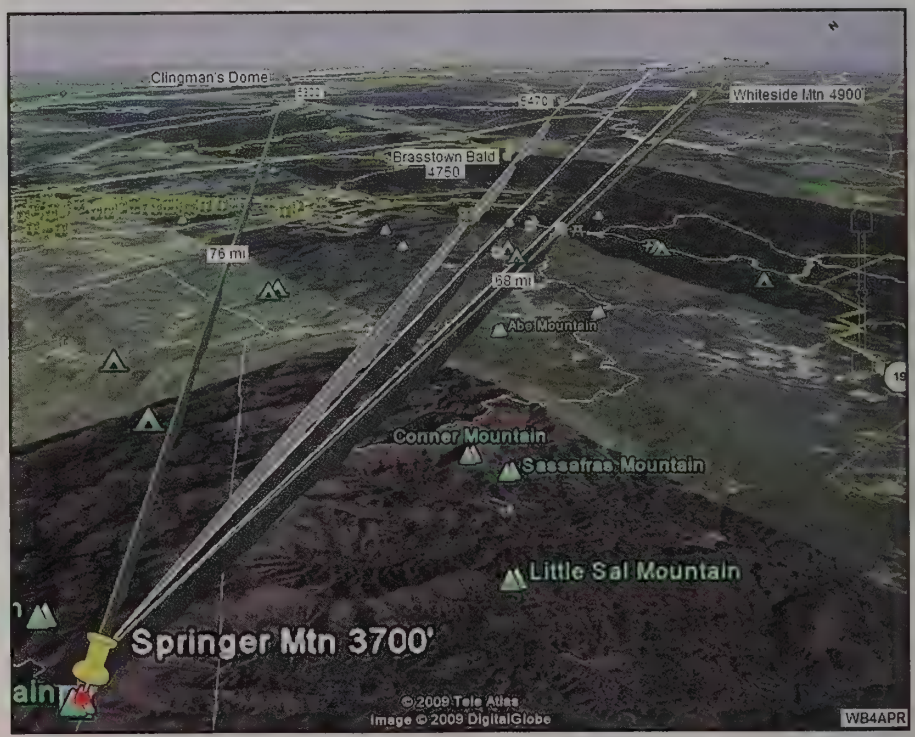
Mill Mountain, team needed

Maryland Mountains, WB4APR will cover and be central relay point

Gov Dick Hill, SE of Harrisburg, team needed

Camelback Mountain, NY, looks like

Google Earth Graphics of the line-of-sight path between Mt. Washington in New Hampshire and Mt. Katahdin in Maine. (Graphic courtesy of WB4APR)



Google Earth Graphics layout of line-of-sight accessible points from Springer Mountain in Georgia. (Graphic courtesy of WB4APR)

a ski area, and therefore we need to secure access privileges ahead of time; team needed

Mount Greylock, a well-known site, N1NCI-3 digi, DX club on board

Mount Washington, another well-known site, team KQ1L-7

Sugarloaf, team needed

Mount Katahdin, a rugged climb, *strong* team needed!

The most important thing we need is a list of any existing emitters on these existing mountains that we can monitor from other sites to help passively determine path quality. We also need lots of teams to help activate all those peaks. There are many good spots still available, so please consider joining us.

Geography

Many of the images in this article were generated by using Google Earth. To learn how use Google Earth to observe RF paths see: <http://www.aprs.org/hamtrails/aprsGoogleEarth.txt>. Other web useful line-of-sight tools can be found at Mountain Peaks and Summit Names. This tool creates simulated views from peaks (great for line-of sight); see: <http://www.mountainpeaks.net>. Mountain Peaks, Summits, and High Points—find a nearby peak for your next Peak-2-Peak event (see: <http://www.mountainzone.com/mountains/>).

The following is a list of some of the highest points along the trail; some are on the previous list, and some are not. The ones that are not slated as APRS sites would be great vantage points for those hams who want to observe the event via FM voice, but do not want to take part in the main APRS event. These hams would function as human repeaters passing traffic and helping to coordinate the fun.

Georgia: Blood Mountain, 4,461'

North Carolina/Tennessee: Clingmans Dome, 6,625'

Virginia: Pine Mountain, 5,500'

West Virginia, Peters Mountain, 3,956'

Maryland: Quirauk Mountain, 1,880'

Pennsylvania: Big Pine Flat Ridge, 2,080'

New Jersey: High Point State Park, 1,685' (base of observation platform)

New York: Prospect Rock, 1,433'

Connecticut: Bear Mountain, 2,316'

Massachusetts: Mount Greylock, 3,481'

Vermont: Killington, south-southwest slope, 4,010'

New Hampshire: Mount Washington, 6,288'

Maine: Katahdin, 5,267'

Please remember that this is *not* VHF contesting. This is *not* weak-signal work. We must have dead-solid FM packet links with 90-percent-plus reliability! Also remember that after seven hops that it equates to only a 50-percent chance. Therefore, if your shack is anything like mine (comfortable and full of high-tech gadgetry), here is a real chance to get out and enjoy the great outdoors. Working VHF/APRS in the high country will be technologically challenging while at the same time a whole lot of fun. This should be a very exciting event and a good opportunity to get on to those mountain-tops and play radio! This is also great chance to practice all of those Field Day skills and learn more about packet radio. It will be a tech-friendly and QRP-friendly event. Therefore, we encourage you to get out and get involved! ■

CDE/Hy-Gain Rotors
How to Keep 'em Turning – Part II

In Part I of this series, we looked at how to repair the most commonly experienced problems with bell-shaped CDE/Hy-Gain rotors. Despite Murphy's best efforts, not all rotor (rotator) system problems are found on top of the tower. Sometimes the problem can be found, and corrected, in the shack. In this part, we'll cover what can happen to the various styles of controllers that are used with these rotors and how to identify and repair those problems.

By Brad Pioveson,* W9FX

An often-seen post on antenna-related e-mail reflectors inquires about what kind of controller one can use with specific types of CDE/Hy-Gain rotors. The answer is an equivocal, "It depends."

The history of these rotors can be traced back to the days of the CDE Ham M-series. These first rotors were delivered with a controller that sported a single, lever-operated switch and a large meter, housed in a compact brown or black plastic case (photo 1). That single-lever switch performed all the functions needed to move the antenna remotely. When the operator pushed the lever to the left, the switch energized the rotor's brake-release solenoid while applying power to the rotor motor, turning the rotor in the counterclockwise direction and simultaneously engaging the DC circuit that turned on the indicator meter. When the operator released the lever switch, power was simultaneously removed from the DC circuit, the brake solenoid, and the rotor motor. The brake wedge, no longer held back by the energized solenoid, thus instantaneously slammed into the nearest groove in the rotor's lower housing, regardless of any movement of the antenna/mast assembly. Inertia was a diabolical enemy of these brake wedges. Hams with sizable antenna arrays mounted above Ham M rotors soon learned how to change brake wedges, as they would often shatter from the rotational torque applied to them.

There were four "series" of Ham M rotors. Series 1 or 2 rotors must be mated with Series 1 or 2 controllers. If you are unclear on that point, let me suggest you read that sentence again. Failure to heed this warning invariably results in expensive "smoke" being liberated from both rotor and controller.

Series 3 Ham M rotors featured improvements that changed the rotors into the electrical configuration still in use today. In other words, a Series 3 Ham M rotor is electrically the same as Ham II, Ham III, Ham IV, Ham V, and TailTwister rotors. The Ham M Series 3 and 4 controllers will electrically operate any of these rotors. It's not a terribly good idea to use the old single-lever controllers on these more modern rotors for the reasons outlined above. If, however, you are in a pinch, have a light load on the rotor, and are careful to avoid moving the antenna during high winds (which might add to the rotational torque on the system), you can get by with an old, single-lever controller.

The single-lever controllers will happily work without any kind of restrictions

Photo 1. Examples of three rotor controllers. The top one sports a single lever-operated switch and a large meter. The bottom two show the later additions of the direction control and brake switches (lower right in both controllers), as well as the calibration and on/off switches (upper right on both controllers). (Photos by the author)

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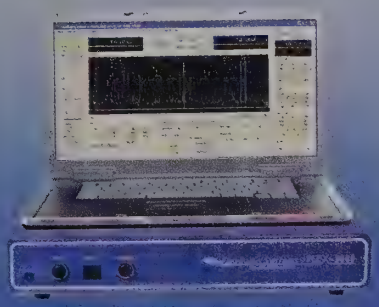

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when coupled to the TR-44, CD-45, and, CD-45 II rotors. These rotors are not equipped with brake wedges, so the lack of the ability to independently control the brake is immaterial.

The Ham M Series 5 rotor from CDE addressed the problems with brake-wedge shearing, a problem that plagued the single-lever controller owners. With this new model, CDE introduced the three-switch controller. This unit sported one push-type lever switch each for CCW and CW rotation, and a third switch to engage/disengage the brake wedge. With this innovation, CDE changed the name of their rotor to the Ham II.

Since the Ham II rotor controller was introduced, the only major changes to these controllers have been in appearance and housing styles (again, see photo 1). With the advent of the Ham IV units, point-to-point and point-to-terminal-strip wiring (see photo 2) was replaced with a single PC board that mounts to the back of the unit's meter, held in place by the meter terminal nuts (see photos 3 and 4).

The TailTwister (or T2X) controller is a special case. This unit is, in all functional respects, the same controller used in the Ham IV units (and its predecessors, as noted above), except for the addition of a couple of LEDs that are installed in the front panel. The LEDs dress up the panel a bit and offer the operator some visual feedback that CW or CCW rotation has been commanded. Truth be told, the rotor doesn't care whether or not those LEDs exist, so a TailTwister rotor can be controlled using a Ham II controller.

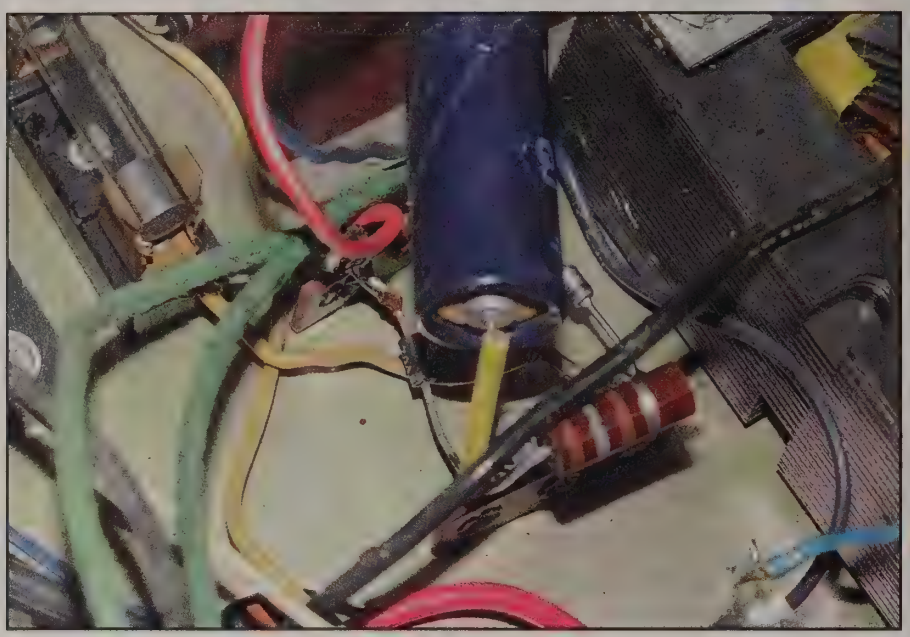
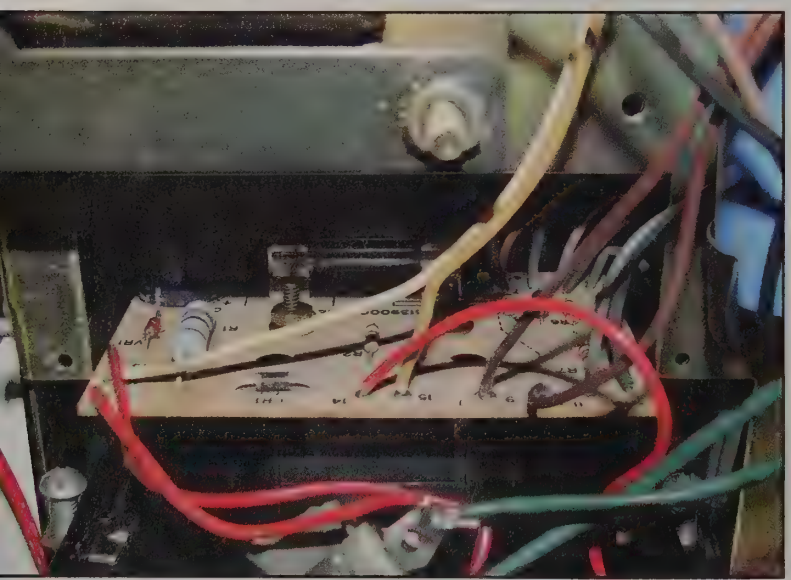


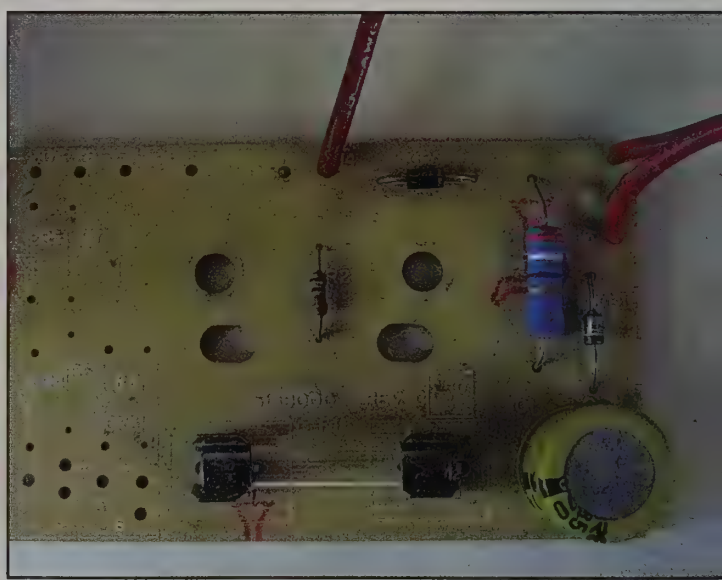
Photo 2. An example of point-to-point and point-to terminal wiring. The zener diode is wired between two terminal strips in the center of the photo. The location of the 3-amp fuse is in the upper left corner of the photo.

Theory of Operation and a Caution

Note: Some of the checks and tests require that the rotor controller be powered up—i.e., attached to the AC line and energized. Depending upon your individual unit, the AC line voltage can be either 120 VAC or 240 VAC. ***This voltage can seriously injure or kill you. Use extreme caution.*** If you are unfamiliar with the safety precautions that must be used when testing energized circuits, refer the unit to someone who is.

The controllers[1]—from the Ham M Series 3 all the way to the most modern units—provide AC and DC voltage and current to the rotor, and measure the DC current across the rotor's rheostat (azimuth potentiometer) to give the meter indication in the shack. There are two transformers in the controller. One provides the AC voltage for the motor and brake circuits, and the other is an instrument transformer from which AC volt-





Photos 3 & 4. A single PC-board, which mounts to the back of the unit's meter. The zener diode that is identified as VR-1 on the PC board is located on the left edge of the board in photo 3 (lefthand photo) and on the right edge of the board in photo 4.

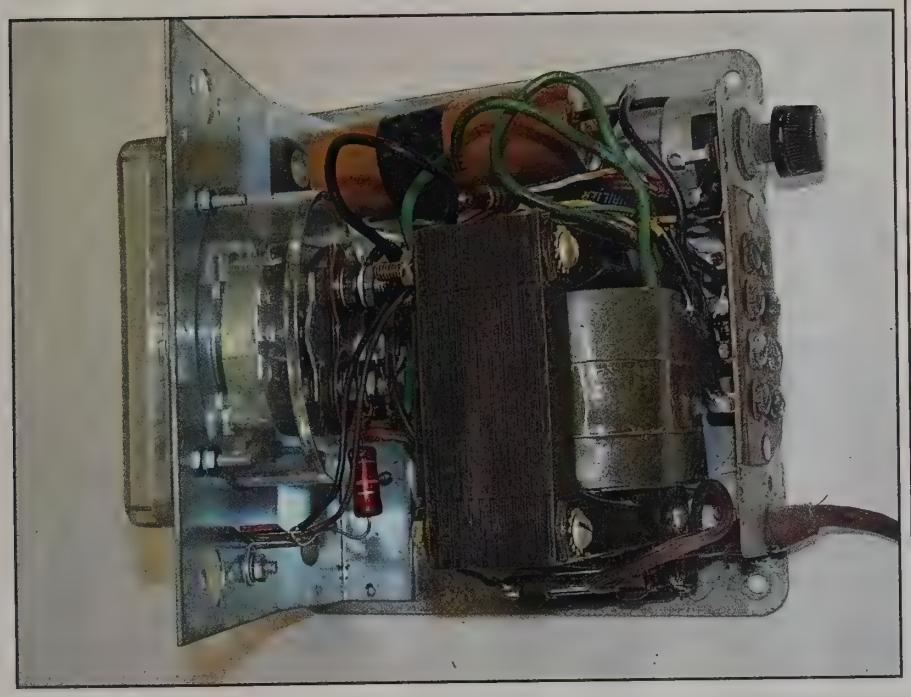


Photo 5. The location of the 3-amp fuse is in the lower edge of the photo, just below the transformer.

age is derived and rectified. This rectified half-wave DC is "regulated" by a 1N4743 13-volt 1-watt zener diode to provide the DC voltage used by the meter circuit. This zener diode is identified on the PC board legend as "VR-1." (See the left edge of the circuit board in photo 3 and the right edge of the circuit board in photo 4). In the Ham II controller, this zener is wired between two terminal strips (see photo 2).

There are two fuses in the modern controllers. One of these fuses protects the overall current demand of the rotor system. This is a 3-amp AGC-style fuse. Note that this is a 3-amp fuse, not a 30-amp fuse. In the lever-switch controllers, this fuse is located inside the housing, in a fuse holder (photo 5). In the Ham II and later controllers, this fuse is located on the back panel (photo 2). New replacement transformers and meters are expensive.

The second fuse protects the instrument transformer. These are 1/8-amp AGC-type fuses. Again, I strongly encourage you to use the proper size of replacement fuses, and I remind you that fuses do not get tired or old and simply open for no reason. If one of the fuses in your controller opens, it's time to troubleshoot the system and find out why the protective elements did their jobs.

The most common gripe among CDE/Hy-Gain controller owners is that the pilot lamp—the meter illumination lamp, if you will—fails. These are easily replaced, and are GE number 1819 lamps, available from electrical and illumination suppliers. These lamps, like all incandescent bulbs, generate heat. The plastic-housed, modern controllers have a piece of aluminum tape affixed to the underside of the top cover. That aluminum strip is placed there to prevent the heat from the pilot lamp from warping the plastic cover. If the tape is gone, it would be a good idea to replace it using aluminum duct tape. A 1-inch square piece is adequate (see photos 6, 7, and 8).

There are three options currently available for replacing a failed incandescent built with long-life LEDs. There are direct-replacement LED lamps. These can be directly substituted for the number 1819 bulb. I have one of these in one of my Ham III controllers and it does a fair job, but the cone of light transmitted by the LED doesn't fully illuminate all of the meter face. Recently, I noted that Idiom Press is marketing a small PC board equipped with three LEDs and the necessary voltage dropping circuitry.[2] This substitute for number 1819 lamps would appear to be a perfect fit, both in terms of size and application, and interestingly is priced at less than what I had to pay for an industrial LED number 1819

lamp substitute. Finally, for those comfortable with the use of hand tools, one could reuse the base of a bayonet bulb, fitting a high-intensity LED and a suitable voltage dropping resistor into the base, making your own LED substitute.

The Meter Doesn't Work

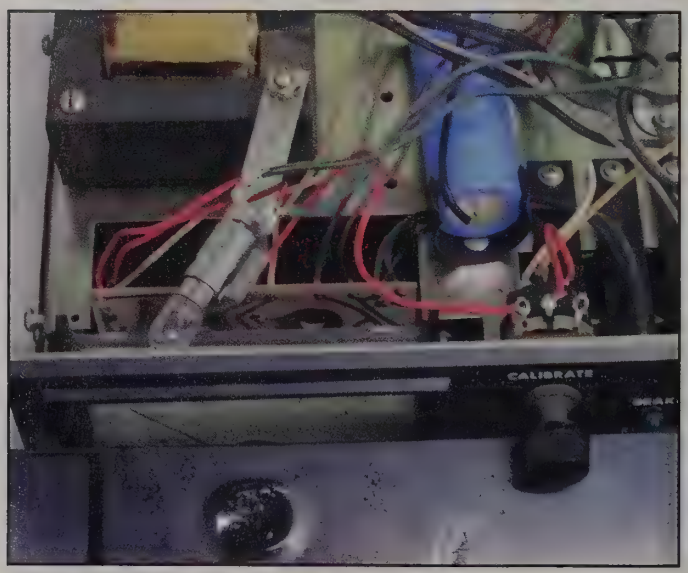
If your rotor is working, moving left and right, and the brake is operating properly but the controller meter isn't indicating, it's time to get out the VOM. Before you do anything else, make sure that the rotor cable connections to the back of the controller are secure. If everything appears well there, set your VOM to DC volts and attach your probes to terminals 3 and 7 of the controller (see photo 9). With the controller turned on (not necessary to release the brake or turn the rotor), you should see ~13 VDC across those two terminals. If you don't see that voltage, the problem is in the controller. If you do find the DC voltage to be on those terminals, the problem lies either in the cable or the rotor.

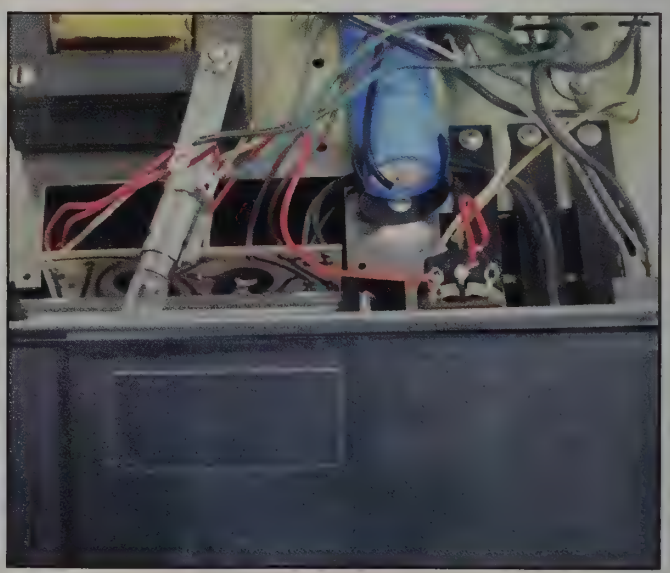
Assuming you didn't find any DC voltage coming out of the controller, you are going to have to troubleshoot the DC circuit inside the controller. Now, before you do anything else, unplug the line cord and remove AC power from the controller. Then proceed to remove the top cover from the controller. The first thing to check is the DC circuit fuse. That's the 1/8-amp fuse I mentioned in the paragraphs above. It will be located either on the PC board mounted to the meter terminals (see photos 3 and 4), or in older controllers, in a fuse clip mounted to the chassis (see photo 10). Pull the fuse out of the holder and check it for continuity. If it's open, you may be able to squeak by with a replacement fuse. EMP discharges from lightning strikes can cause these fuses to blow. If the replacement fuse pops as soon as you try the controller again, you're going to have to dig a little deeper.

If the DC voltage is present on terminals 3 and 7 of the controller and the meter is still providing no indication, turn off the controller and remove the wires from terminals 1, 3, and 7, after having noted the colors of the wires so that you can properly rewire the controller. If you have a Cinch-Jones connector equipped controller, disconnect the plug from the controller's socket. You are about to remotely check the "health" of the rotor's internally mounted azimuth potentiometer (and/or the cable between the controller and the rotor). The azimuth potentiometer's value is approximately 500 ohms.

Using your VOM in resistance-mea-

Photos 6, 7, & 8. These photos illustrate the effect of the hot bulb on the plastic cabinet. Note the bubbling of the cabinet just above the meter in photo 6 (left) and in front of the meter in photo 7 (bottom left). This effect is why it is necessary to ensure that the duct tape shown in photo 8 is securely in place. Both photos 7 and 8 (bottom right) also show the starting capacitor, which is blue.





suring mode (ohms), check for the presence of approximately 500 ohms of resistance between the wires that were attached to terminals 3 and 7. Write down your measurement.

Next read the resistance between wire 1 and wire 3. This should be somewhere between a few and approximately 500 ohms. Record this measurement.

Now measure the resistance between wire 1 and wire 7. Again, this should be between a few and 500 ohms of resistance. Record this measurement.

The arithmetic sum of these last two measurements' values should equal the total resistance as measured between wires 3 and 7.

If you read an open circuit (infinity resistance) between wires 3 and 7, the rotor cable is damaged, the connection at the rotor has a problem, or the rotor azimuth potentiometer has failed. Part I of this article discussed replacing those potentiometers.

If you read a short circuit—or nearly so—between wires 1 and 3 and wires 1 and 7, the problem, again, could either be cable, wiring connection (at the rotor), or a failed potentiometer. In this case, I would strongly suspect a failed potentiometer. Wire/terminal 1 in the Ham-series rotors is ground for both the DC and AC circuits.

The Meter Works but the Rotor Won't Turn

If your controller's meter is working and indicates the direction in which the rotor has stopped, but your efforts to move the rotor result in no movement, there are a couple of checks you can make from the shack. (*Note: The following checks will not apply to the TR-44/CD-45/CD-45 II rotors, as they have no wedge brakes.)*

• Release the rotor's brake by pressing the "Brake Release" switch or moving the lever switch left or right and listen (or, have a friend do this for you) for the resounding "thunk" from the rotor. That noise is the brake solenoid operating.

• Using your VOM in AC volts range, the cable wired to the controller, and the controller's AC power OFF, attach your probes to terminals 1 and 2 of the controller. Turn on the AC power to the controller and depress the Brake Release switch and hold it, or if you are working with one of the older, lever-style units, move the lever switch left or right and hold it. You should measure approximately 26 VAC. Release the switch and turn the controller OFF.

• If you have access to a clamp-on AC ammeter, clamp it around wire 1 or wire 2 (not both). Turn on the controller, energize the brake release, and read the AC current in the circuit. This current should be in the 1-ampere range. If, however, this current is measured at significantly more than 1 amp (I have measured them at up to 15 amps!), power down the controller and get your climbing belt.

What you just checked was the brake solenoid circuit. The controller places AC power to terminals/wires 1 and 2 to energize the solenoid. The solenoid retracts the attached brake wedge – which is, just as it sounds, a wedge of steel that mates with grooves cast into the inside of the lower rotor housing. If the voltage is

Photo 9. This photo shows the terminals in the upper right. The blue starting capacitor is also shown.

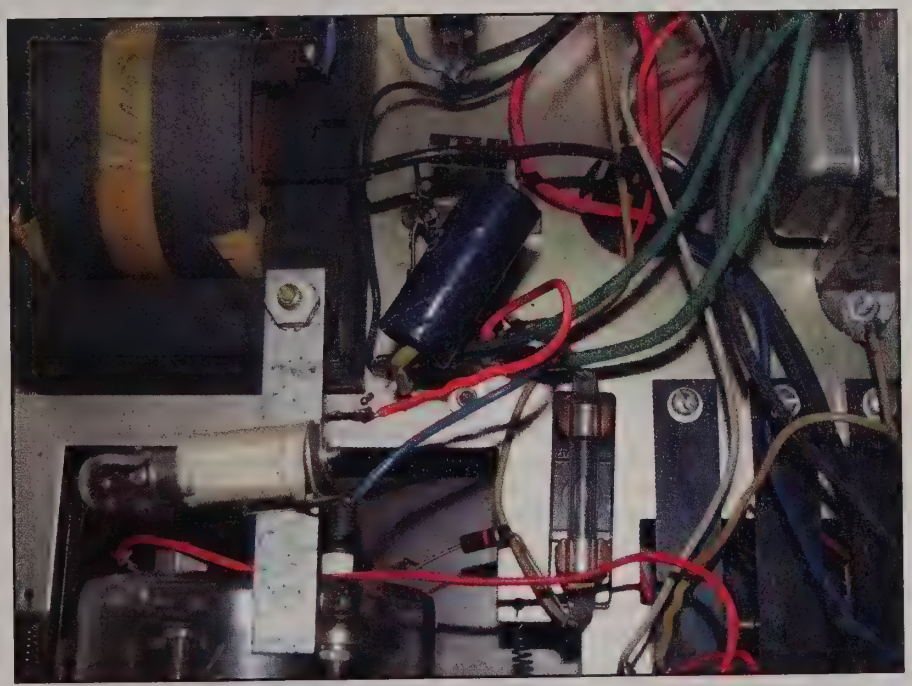


Photo 10. The location of the 1/8-amp fuse, which is located to the right in the photo.

there, and the current is within norms, the solenoid circuit is intact and the solenoid has not become mechanically jammed. If, however, the voltage is correct but the AC current is high (up to 15 amps), the solenoid, which is attached to the brake wedge, has become mechanically bound or blocked, and therefore the rotor cannot move. It's time, in that case, to get the rotor down and onto the bench for repairs.

TailTwister rotors are notorious for having the occasional brake wedge idiosyncratic problem. The brake wedges in the T2Xs from time to time tend to stick in the grooves of the lower housing. In later production years, Hy-Gain modified the profile of the steel wedge to help eliminate this problem. The "field engineering solution" (ham shack work-around) is simply to nudge the rotor, with the brake release engaged, alternately CCW and CW—i.e., rocking it a bit, to help release the wedge.

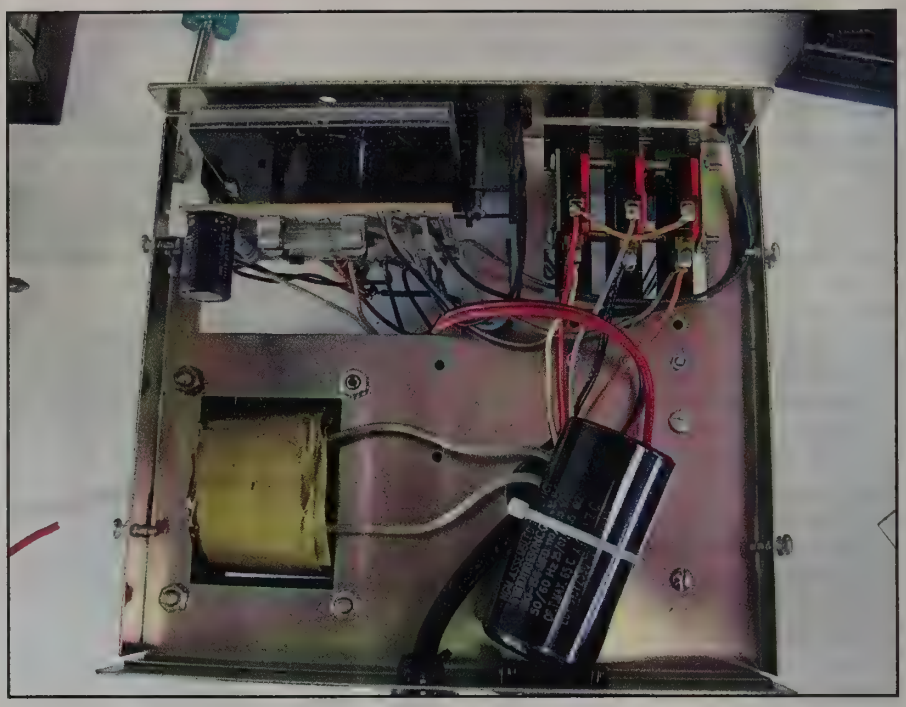


Photo 11. This photo shows the newer starting capacitor, which is black.

The Brake Circuit is OK but the Rotor Still Won't Turn

If the brake solenoid is operating, appears not to be jammed, and the rotor still won't turn, then it's time to check the motor circuitry. The motor circuit consists of a split-phase AC motor. This motor is provided with ~26 VAC by the controller. The voltage appears across terminals/wires 1 and 4 or 1 and 6, depending upon the direction of rotation.

- Remove AC power from the controller and disconnect the wiring from terminals 1, 5, and 6 (again, note colors for rewiring later).
- Using your VOM in a low ohms range and measure the resistance between wires 5 and 6. This measurement should indicate just a few ohms; the motor itself represents about 3.5 ohms of resistance, plus you'll have the resistance of the rotor cable added to that.
- Measure the resistance between wires 1 and 5, and then 1 and 6. These two measurements, added together, should equal what you read in the previous test.

If the resistance readings are in the ballpark, good news: It would appear that the motor, and cable, are electrically intact.

- Reconnect all rotor cable wires to the controller.
- Set your VOM to AC volts and attach your probes to terminals 1 and 5.
- Energize the controller, release the brake, and press the CW (right) rotation switch. You should see approximately 26 VAC indicated on your VOM.
- De-energize the controller and attach your probes to terminals 1 and 5.
- Energize the controller, release the brake, and press the CCW (left) rotation switch. You should see approximately 26 VAC indicated on your VOM.
- De-energize the controller.

If your controller passed these tests, and if your controller is over four or five years old, it is possible that the motor start capacitor, which is housed in the controller, has failed.

Motor Start Capacitors

Every CDE/Hy-Gain rotor controller has a motor start capacitor wired into the circuit (see photos 5, 7 through 9, and 11). This capacitor is located inside the controller, thankfully, and not inside the rotor. The first signs of an aging (and thus failing) motor start capacitor is that the rotor will begin to move sluggishly. If your rotor used to turn smartly and, say, make a full revolution from stop to stop in 70 seconds but the unit has started slowing down, your motor start capacitor needs to be replaced.

These capacitors can be obtained from most electrical-supply shops and probably all motor-rebuilding shops. Industrial suppliers such as W.W. Grainger, etc., have them as well, and they aren't expensive. These non-polarized capacitors used to be housed in paper sleeves. Modern versions are housed in plastic tubes. Put another way, the new ones are substantially larger in physical size than their older cousins (see photo 11).

The value of these capacitors is not critical. When the controller was built, the factory installed 120–140 µF capacitors. These days, the 136–156 µF, 110–125 VAC units are the available replacements. Both Mallory and Sprague manufacture these capacitors.

Squeezing the larger capacitors into the controller housing can be a little problematic. Depending upon the type and age of your controller, you may find the original capacitor retained in a spring clip installed on the upper chassis of the controller. The new capacitors are too big to fit into that clip. As an alternative, you can squeeze a new capacitor into the controller under the chassis. I have successfully used cable ties and an adhesive-backed cable-tie retainer to keep the capacitor in place (again, see photo 11).

If you're using one of the older, lever switch controllers, it's not possible to easily fit the new capacitor into the controller's housing. You can, however, mount it external to the controller using a cable-tie/tie-point arrangement to secure the tubular capacitor in place. In this case, the wiring can be tied to the screws of the terminal board.

Wiring the new capacitor into the circuit couldn't be easier. There are only

two connections to the capacitor, and it's non-polarized. Using number 16 or number 14 insulated wire, solder one wire to each of the two capacitors' terminals. Solder the other ends of these wires to terminals 4 and 8, respectively, on the backside of the controller's terminal board or C-J connector.

Another interesting motor-start capacitor mounting alternative is taken from the pages of contest operators' e-mail reflector archives. Some of the contest crowd, specifically those with towers located a long way from the station (and rotor controller), have remotely mounted these capacitors, placing them (in a weatherproof container) under the tower's rotor shelf. That negates the need for using 8-conductor rotor cable, by the way. If the capacitor is remotely mounted, you can use less-expensive 6-conductor cable.

Transformers and Meters

Transformers can fail. As noted previously, there are two of these in the controller. One is used to step down the AC primary voltage to the ~30 VAC used by the motor. The other transformer is used exclusively for the DC part of the circuit—i.e., for the metering. Testing a transformer involves (with the controller disconnected from the AC line!) performing resistance checks. The primary wiring of each transformer should measure continuity from end to end. The secondary circuit of each transformer should measure continuity from end to end. There should be infinite resistance measured between the primary and secondary windings of each transformer.

Most often when transformers fail, the transformer will not pass the "sniff test." Transformers that have developed shorted windings generally do so in a dramatic fashion, and the odor is unmistakable.

The meter in your rotor controller is a precision instrument, and testing of the meter with a VOM, depending upon your VOM's open-circuit voltage, can actually cause the meter to fail. The most common cause of meter failure, by the way, is not electrical; it's mechanical. Debris, dust, particles or bits of wiring, solder, insulation, etc., can find their way into the meter movement. Gentle application of air, such as from a lens-cleaning "puff brush" sold for cleaning optical lenses, won't do damage. Using a can of compressed carbon dioxide, such as that currently sold for cleaning computer keyboards, etc., or a blast from an air hose attached to a compressor, can, however, destroy a delicate meter movement in short order.

Meters can also suffer from a residual static charge. If your controller's meter seems to "hang," never returning to zero, or is stuck in mid-range, a very small squirt from a water spray will neutralize the static electricity charge and will free up your recalcitrant indicator.

Replacement transformers and meters are available, with some caveats, from Hy-Gain. As there are so many different styles of controllers, not all meters are available, and a call to Mississippi (1-662-323-5263) will resolve the issue. They are not cheap. Transformers are readily available, although case styles and, in the case of instrument (DC circuit) transformers, the modern OEM parts now have dual primary windings. Likewise, transformers are not cheap, either.

Keep in mind that used CDE/Hy-Gain controllers abound at flea markets and via the various internet swap and auction sites. In many cases, one can purchase a complete, operating, used controller for less than the cost of the more expensive replacement parts. Of course, the used controller may need a new motor start capacitor.

Conclusion

In Part I of this series you were introduced to the basics of CDE/Hy-Gain rotor repairs. In this part (Part II) the most commonly experienced problems with rotor controllers have been discussed, and some troubleshooting hints and tips have been presented to you.

Again, whatever tests you make, whatever repairs you undertake, always keep your safety foremost in mind. ■

Notes

1. Schematics and manuals for currently marketed controllers are available for free download from the manufacturer at: <http://www.hy-gain.com> and for the older units at: <http://bama.edebris.com/manuals/>.

2. Go to: <http://www.idiompress.com/illuminator.html>.

A Pioneer in the Family
Jim Kmosko, W2NLY

In the Summer 2007 issue of *CQ VHF*, WA2VVA began his series on KH6UK. Since then those articles have brought forth communication with other hams of that era who also have much to contribute to the many areas of VHF history. In this article Mark interviewed W2NLY, and here is his story.

By Mark Morrison,* WA2VVA

When *CQ VHF* magazine first published my articles "The Lost Letters of KH6UK" two years ago, I received many e-mails from people recalling how they once knew one or more of the hams mentioned in that series. One was Bill Musa, K5YG (ex-K2MHJ), who told me that he once worked with Jim Kmosko, W2NLY, while at Lockheed Electronics. Bill suggested that I try to contact Jim and write an article about him. I did check my local phone book, as Jim's QTH was nearby, but was not able to find any listing.

Time went by until just recently, when Bill contacted me again about another of my articles and once more suggested I try to locate Jim. This time I did a search on QRZ.com and was happy to see that W2NLY had recently renewed his license. With Jim's address in front of me, I then wrote him a letter introducing myself and telling him about Bill's persistence about contacting him.

A few weeks passed without hearing anything, and then one day there was a message on my answering machine. It was from Jim! I called him back, and he invited me over to talk about the golden days of VHF radio. Considering that he knew almost everyone whom I have written about, it was a real pleasure to talk with Jim and share our memories of that time. This article is based on two separate visits I made to Jim's house this past February and March.

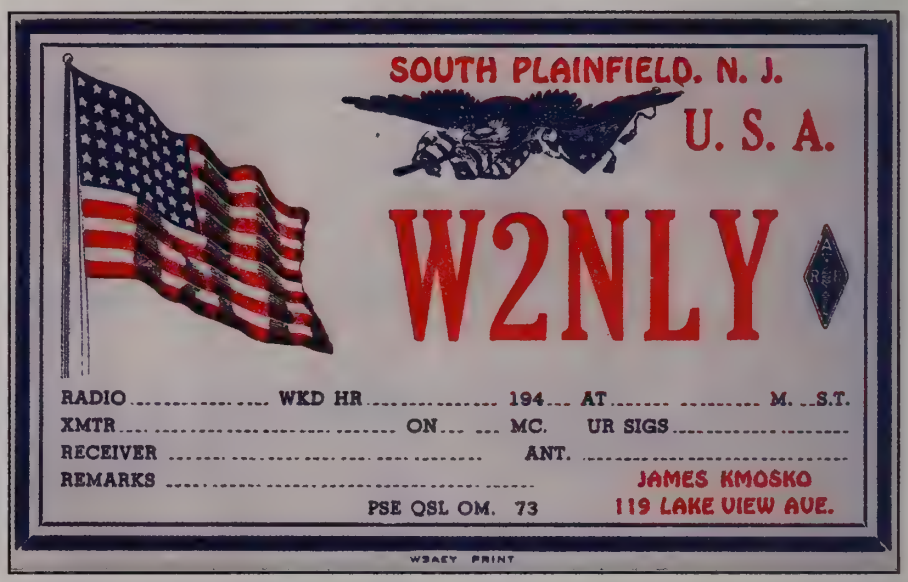


Photo 1. Jim's first QSL card. In 1939, at the age of 19, Jim applied for both his amateur as well as commercial radio licenses.

Hadley Field

On the evening of July 1, 1925 a crowd of 15,000 gathered in South Plainfield, New Jersey to witness history in the making. Great arc lights illuminated the hastily constructed airstrip known as Hadley Field in anticipation of the big event. At 10:30 PM pilots Dean Smith and J. D. Hill revved the engines on their De Havilland DH-4 biplanes and took off for Chicago, loaded with mail. A chain of beacons installed just the year before, and spaced every 10 miles, showed them the way. Thus it was that the world's first nighttime airmail service began.

In the years that followed, Hadley Field would become a fascinating place, not only for the young children who lived nearby, but also for the curious onlookers hoping to catch a glimpse of some famous aviator. This was the age of Wiley Post, Amelia Earhart, and Charles Lindbergh, all of whom would have known this place. It was here that a young boy named James Kmosko would visit with his father, August, to watch the planes take off and land, and who would return many years later to "launch" some of the Navy's first flight trainers.

The Early Years, W2NLY

As with many of the VHF pioneers, Jim's fascination with radio began at an early age. In 1939, at the age of 19, Jim applied for both his amateur and his commercial radio licenses, receiving the call W2NLY. His first QSL card is shown in photo 1.

As a teenager growing up in the 1930s, Jim would often listen to the shortwave bands. Later he would turn to 160 meters, 2½ meters, and even 10 meters when the band was open, using equipment that he built himself. Photo 2 shows Jim at the operating position of his 160-meter sta-

**5 Mount Airy Rd., Basking Ridge, NJ 07920*
e-mail: <mark1home@aol.com>

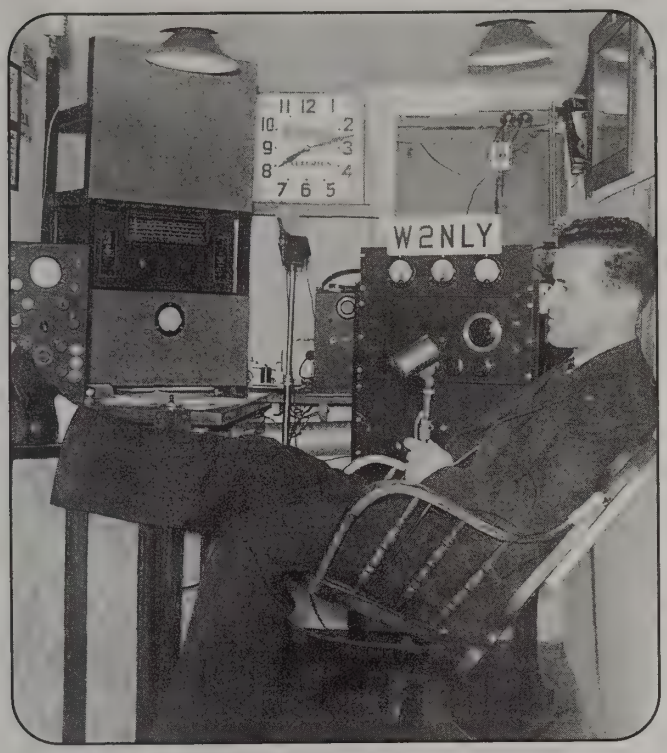


Photo 2. Jim at the operating position of his 160-meter station in South Plainfield, New Jersey in the late 1930s.

tion in South Plainfield in the late 1930s. Jim maintained regular 160-meter schedules with David Roland, W2IWU, most Sunday afternoons following church.

In the early 1940s, Jim worked for the Western Electric Company in Kearny, NJ. It was there that Jim worked on the Army's ubiquitous VHF searchlight control radar, the SCR-268. Jim recalls those early days, describing how the parking lot in Kearny would be filled with as many as 400 such radar units housed in wooden shelters and all directed over the Jersey meadowlands toward the biggest radar target of the time, the Empire State Building. Photo 3 shows an SCR-268 being prepared for a test. Note the two operators standing on the unit.

The SCR-268 used a broadside transmitting antenna and two separate receiving antennas, one for elevation and the other for azimuth. Separate oscilloscopes, one for each receiving antenna, were monitored by individual operators and used to manually track objects. When three such radar units were used to point separate carbon arc lamps, the target would be revealed where the three light beams intersected.

Jim mentioned that you had to be very careful when tuning these units because of the high power they employed. It was possible to be standing 20 feet away holding a quarter-wave stub and observe ionization effects similar to those of a Jacob's ladder, with an arc traveling up and down the stub. Cable layout was also important because of corona effects. Jim described the oscillator unit as having a ring of VT-127s, a tube later available as war surplus and excellent for 2-meter work. The circular arrangement of these tubes allowed the operators to judge their condition simply by comparing the color of adjacent tubes.

The SCR-268 worked at frequencies on the order of 205 MHz, a rather uncommon frequency in amateur radio circles with the exception of the father of radio astronomy, Grote Reber, W9GFZ, who was publishing VHF articles in the mid 1930s.

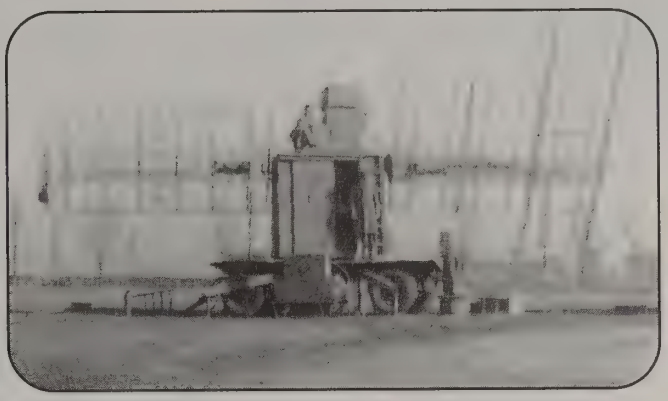


Photo 3. An SCR-268, the Army's ubiquitous VHF searchlight control radar, being prepared for a test at the Western Electric Company in Kearny, New Jersey. Note the two operators standing on the unit.

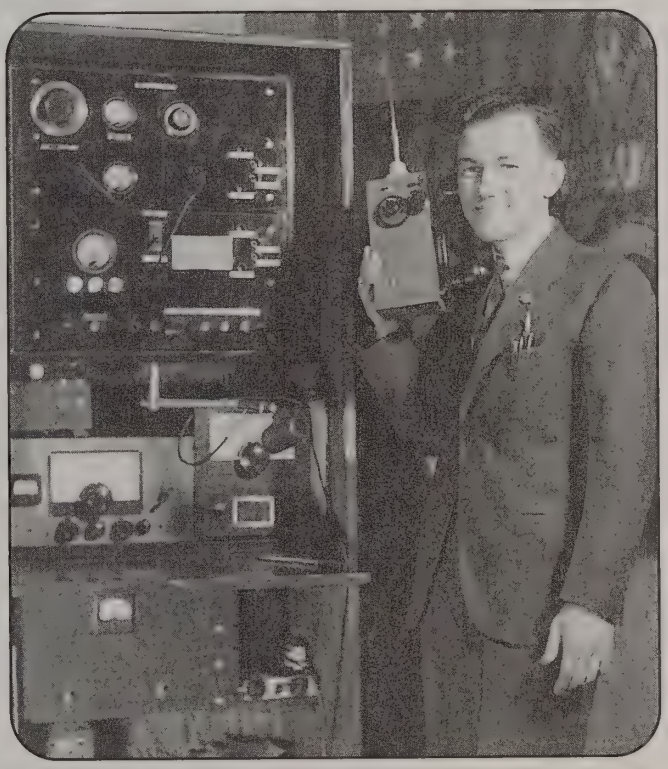
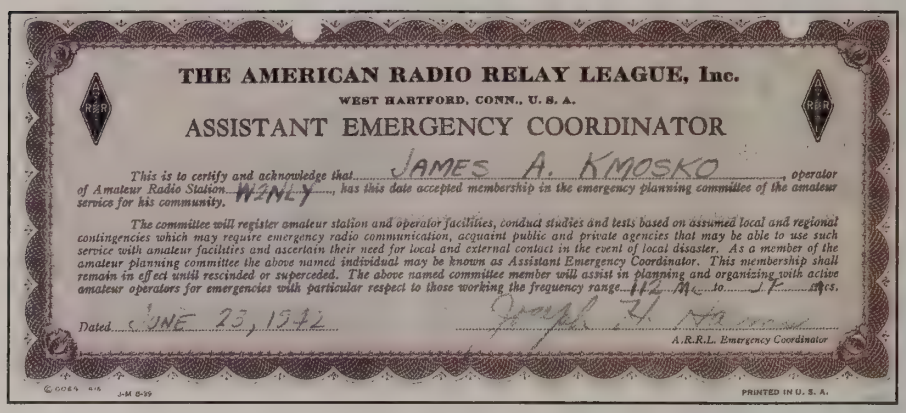


Photo 4. In 1942 Jim designed and built the War Emergency Radio Station (W.E.R.S.) used by the town of South Plainfield and assigned the special callsign WJSQ by the FCC. This is the station.

Jim's own experience with this radar equipment would pay off later when the FCC allocated the 2-meter band for amateur use.

The War Years

During the war years, amateur radio operations came to a halt and all but emergency stations were forced off the air. In 1942 Jim designed and built the War Emergency Radio Station (W.E.R.S.) used by the town of South Plainfield and assigned the special callsign WJSQ by the FCC. Jim describes the station, shown in photo 4, as follows: "This station was part of a state and nationwide network to back up normal police and fire communication in case of loss of power, etc. The headquarters



THE AMERICAN RADIO RELAY LEAGUE, Inc.
WEST HARTFORD, CONN., U. S. A.
ASSISTANT EMERGENCY COORDINATOR

This is to certify and acknowledge that JAMES A. KMOSKO, operator of Amateur Radio Station W2NLY, has this date accepted membership in the emergency planning committee of the amateur service for his community.

The committee will register amateur station and operator facilities, conduct studies and tests based on assumed local and regional contingencies which may require emergency radio communication, acquaint public and private agencies that may be able to use such service with amateur facilities and ascertain their need for local and external contact in the event of local disaster. As a member of the amateur planning committee the above named individual may be known as Assistant Emergency Coordinator. This membership shall remain in effect until rescinded or superceded. The above named committee member will assist in planning and organizing with active amateur operators for emergencies with particular respect to those working the frequency range 112 Mc. to 1? mcs.

Dated JUNE 23, 1942

A.R.R.L. Emergency Coordinator

PRINTED IN U. S. A.

Photo 5. For W.E.R.S., Jim was assigned WJSQ-2 for his car. This photo shows the certificate issued to Jim for his amateur service in this regard.

station was … operated at 112 mc, in the 2½-meter band." Jim's dad, August, built the cabinet enclosure. This equipment had its own emergency power source and was located on the second floor of the Police and Fire Headquarters building on then Hamilton Blvd. South Plainfield hams included Joe Harms, W2JME (Emergency Coordinator), who was assigned WSJQ-1 for his mobile station. Jim, W2NLY, was assigned WJSQ-2 for his car, and Tom Meeker, W2MDD, was assigned WJSQ-3. The handheld device Jim is holding in the photo is a 2½-meter walkie talkie he made from an old toolbox that held dry cells for power. Photo 5 shows the certificate issued to Jim for his amateur service in this regard.

Many other hams operated emergency equipment from their cars and participated in scheduled and surprise drills relaying emergency messages in town, town to town, and town to state headquarters to test this nationwide W.E.R.S. Photo 6 shows Jim with the rig he used from his car, yet another walkie talkie!

Jim was a member of the Tri-County Radio Club, which met in the Plainfield area. This club was attended by many budding VHF men, including W2AZL, W2CXY, and others. Jim remembers visiting Carl, W2AZL's house on Coolidge Street, just up the road in Plainfield, which was perhaps at one of the earliest meetings of the Basement Laboratory Group (see WA2VVA's series of articles on the Basement Laboratory Group in the Summer 2008, Fall 2008, and Winter 2009 issues of *CQ VHF*—ed).

After the War

Jim's radar work at 205 MHz and W.E.R.S. work at 112 MHz prepared him well for the 2-meter band when it was allocated to amateurs following the war. Nowhere is this more evident than in the many VHF contests in which Jim participated. Throughout the 1940s the ARRL conducted yearlong VHF competitions, known as V.H.F. Marathons, in order to gauge the amount of activity existing on these bands. Jim won the competition in 1946 and again in 1947. The certificate awarded to Jim by the ARRL (see photo 7) notes "Highest score in Marathon history."

In September 1947 Jim published his classic *QST* article entitled "An Antenna that Multiplies by 50." This article described the antenna Jim used in the VHF marathon that year. The basic design for this antenna would be used in many different configurations, each intended to extend the reach of Jim's signals, with considerable mention in *QST* and *CQ* at the time.

Jim's Designs, 1947–1949

When Western Electric decided to move its radio division from Kearny,

Photo 6. Jim with the rig he used from his car for W.E.R.S., yet another walkie talkie!

New Jersey, to Winston Salem, North Carolina in 1947, Jim found work in a start-up company, Stavid Engineering, formed by three former Western Electric engineers. This company developed special electrical and electromagnetic equipment, such as flight trainers, for the military. Jim recalls the first time he walked into the Stavid offices, which were located over a fish company in North Plainfield, only to be greeted by Dave Roland, W2IWU, the same person he had worked on 160 meters years

The American Radio Relay League, Inc.
West Hartford, Conn., U.S.A.

CERTIFICATE OF ACHIEVEMENT
V.H.F. MARATHON

By these presents the American Radio Relay League certifies that J.A. KMOSKO, operator of Amateur Radio Station W2NLY, is the winner of the Very-High-Frequency Marathon for the period Jan 15- Dec. 15, 1947, by virtue of communicating with 803 v. h. f. stations for a score of 7358 points in accordance with the published rules.

Highest score in Marathon history.
Also High score in the 40th, 8th, and 4th Reporting Periods

Award Committee

Feb. 10, 1948

Photo 7. Throughout the 1940s the ARRL conducted yearlong VHF competitions, known as V.H.F. Marathons. Jim won the competition in 1946 and again in 1947. This is the certificate awarded to Jim by the ARRL, noting "Highest score in Marathon history."

AOR introduces the AR-*Mini*

Big Features! Small Size!

This pocket-size communications receiver delivers BIG performance!

The AR-Mini offers legendary AOR quality and a wide array of the most popular features found in the AR-8200 Mark III. But, the new AR-Mini does it all in a convenient pocket size water resistant version that's very easy on a budget.

Whether you use it for work or pleasure, you can take the AR-Mini with you to listen to public safety communications, airline traffic, marine communications, weather channels, trackside communications at car and motorcycle races, radio and television reporters in the field, shortwave communications from around the world, amateur radio frequencies, AM and FM radio signals, analog TV audio and more.

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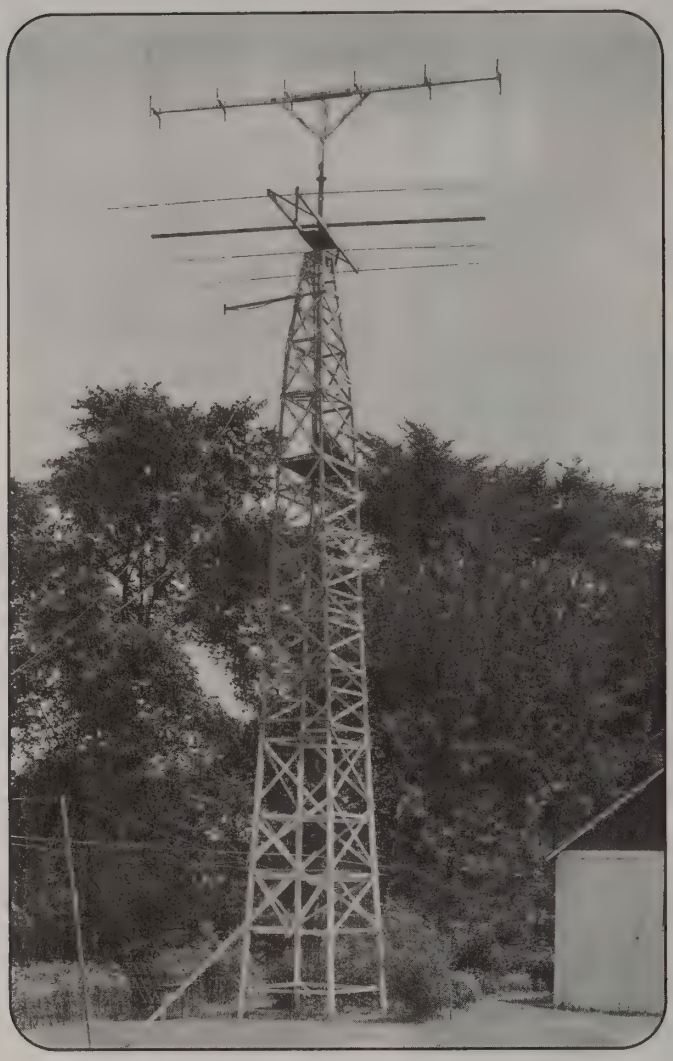


Photo 8. Jim's "Antenna that Multiplies by 50" perched atop the 40-foot tower he constructed in his back yard. This vertically polarized broadside-array antenna bears some resemblance to early radar units such as the SCR-268 that Jim worked on years earlier. Note also the beam for 10 meters.

Photo 9. In 1949 Jim moved from South Plainfield to neighboring Oak Tree. This is Jim's QSL card from that time. Note the illustration showing his "Antenna that Multiplies by 50" and a new wooden tower design.

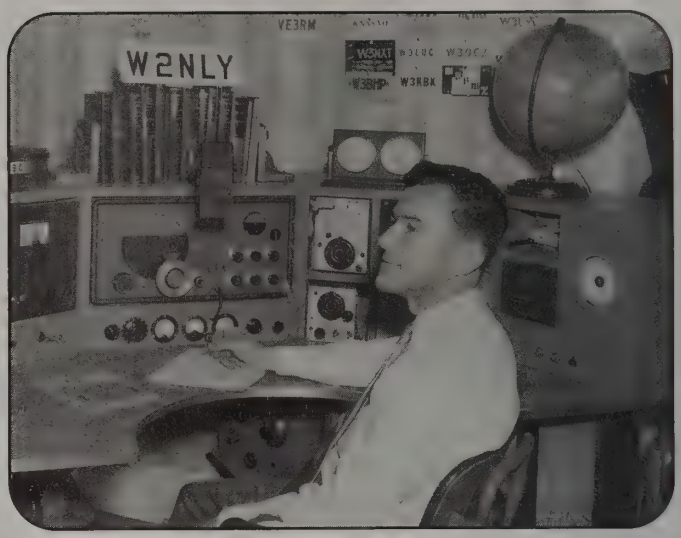


Photo 10. Jim at the operating position of his Oak Tree, NJ QTH. The station consisted of a 2-meter converter and a Panadaptor that he built himself, as well as an SX-42 receiver. The unit on the far left is a narrow-band IF device that he used for experiments with Walt Bain, W4LTU.

before. With little more than an introduction, Dave said, "You've got the job!"

Jim enjoyed building his own receivers and unlike most VHF men of the day, also designed his own 2-meter converter. Jim says it was something similar to the classic W2AZL converter only using different tubes. Although Jim would become well known for his antenna designs, less well known are the towers he used to support them. Resembling works of art with their gentle curves and distinctive cross-bracing, these towers were entirely made of wood! Photo 8 shows Jim's "Antenna that Multiplies by 50" perched atop the 40-foot tower he constructed in his back yard. This vertically polarized broadside-array antenna bears some resemblance to early radar units such as the SCR-268 that Jim worked on years earlier. Note also the beam for 10 meters. Jim says his wife was very understanding!

Oak Tree QTH: Designs and Experiments

In 1949 Jim moved from South Plainfield to neighboring Oak Tree, a town close to Edison, NJ. Photo 9 shows Jim's QSL card from that time. Note the illustration showing his "Antenna that Multiplies by 50" and a new wooden tower design. In this view it really does look like a radar antenna!

Photo 10 shows Jim at the operating position of his Oak Tree, NJ QTH. This station consisted of a 2-meter converter and a Panadaptor that he built himself, as well as an SX-42 receiver. The unit on the far left is a narrow-band IF device that he used for experiments with Walt Bain, W4LTU. He explained that when working CW, if you set the AGC for a long time constant, you could actually see the S-meter creep upward as a result of ionospheric scattering.

Jim also did a lot of aurora work, adding that it sounded like a hissing sound that would change from T1 to T9 as the antenna was rotated. He mentioned how there were times when an aurora existed but you didn't know it. Many times you could work signals when you wouldn't expect it.

While living in Oak Tree, Jim experimented with different and unique antenna designs, all in an effort to extend the reach

Photo 11. In the November 1950 issue of CQ *magazine, Jim published "More Gain with 30 Elements," an article describing another unique antenna design, one that could be rotated by rope for either horizontal or vertical polarization. Shown here is the antenna oriented in both positions.*

of his 2-meter signals. In the November 1950 issue of *CQ* magazine, Jim published "More Gain with 30 Elements," an article describing another unique design, one that could be rotated by rope for either horizontal or vertical polarization. This was necessary, since most eastern stations were vertically polarized at that time, while most western stations were horizontally polarized. Photo 11 shows this antenna oriented in both positions.

By July 1953 Jim was at the top of the 2-meter standings as published in *QST*. Photo 12 shows some familiar calls, including W2AZL and W2UK, both of whom lived nearby.

In September 1953 Ed Tilton, W1HDQ, did a write up in *QST* called "The Biggest Antenna?" in which he credited Jim with starting a new trend—that of increasing the size of already established arrays. Ed wrote: "Jim started it when he expanded the 'Brownie Beam' to 30 elements and the competition has been going ever since. W2UK went to 40 elements, adding another pair of 5-element arrays to the stack of 6 described by W2NLY." In 1954, Tommy Thomas, W2UK, and Paul Wilson, W4HHK, in Tennessee, were credited with the first-ever meteor-scatter QSO on 2 meters. In an effort to pick up Tennessee as a new state, Jim created a new 48-element antenna as shown in photo 13.

During the *Perseids* meteor shower of that year, both Jim and neighbor Carl, W2AZL, succeeded in completing QSOs with Paul, thus becoming perhaps the third and fourth stations in history to work 2 meters via meteor scatter.

The Lockheed Years

In the early years, Jim's work for Stavid would bring him back to Hadley Field, long since abandoned as an airmail terminal. Jim recalls how his first assignment was to clean out the terminal to make room for Stavid's manufacturing operation. He said there were lots of lanterns, searchlights, and other miscellaneous items left over from the airmail days. Hadley is where the operating shop and electromechanical work were done, and it was also where the first flight trainers were built for the US Navy. Over time the company grew, but when Jim had a chance to join Lockheed Electronics, in nearby North Plainfield, he jumped at the chance. Later, Stavid itself would be acquired by Lockheed and merged with it to become Lockheed Electronics.

While working at Lockheed, Jim was Project Engineer for various radar receivers and also worked on ships to resolve radar problems. One such problem was interference between ship radar and ship communications systems, because as Jim says, "Both had to work." The solution was to design a switch that disabled the radar as it rotated within the ship's superstructure, whenever it was directed toward the communications antennas.

Jim remarks how he got to work on some interesting projects. One such project involved the DEW line, a defense line of radar units positioned at the northern most outreaches of Canada and poised to detect the approach of Soviet jet bombers at the height of the Cold War. Bell Labs was in charge of this project and to save time, it contracted Lockheed Electronics to "militarize" commercial communications equipment from companies such as RCA and Zenith. For a time, Jim and some of his Lockheed coworkers worked out of the Bell Labs facility in Whippany, NJ, the

2-METER STANDINGS

Call	States	Areas	Miles
W1HDQ	13	6	850
W1IZY	16	6	750
W1RFU	15	7	1150
W1MNF	14	5	600
W1BCN	14	5	580
W1DJK	13	5	520
W1CTW	12	4	500
W1KLC	12	4	500
W2NLY	22	7	1050
W2UK	21	7	1075
W2QED	18	7	1020
W2AZL	18	7	1050
W2ORI	16	7	830
W2PAU	16	6	740
W2QNZ	14	5	400
W2SFK	13	6	—
W2DFV	13	5	350
W2CET	13	5	405
W2UTH	12	7	880
W2DPB	12	5	500
W2FHJ	12	5	—
W2BVU	12	4	260
W3RUE	19	7	760
W3NKM	19	7	660
W3QKI	17	7	820
W3KWL	16	7	720
W3LNA	16	7	720
W3FPH	16	7	—
W3GKP	15	6	650
W3OWW	13	6	600
W3KUX	12	5	575
W3PGV	12	5	—
W3LMC	11	4	400
W4AO	20	7	950
W4HHK	19	6	710
W4JFV	18	7	830
W4MKJ	16	7	665
W4OXC	14	7	500
W4IKZ	13	5	650
W4JFU	13	5	720
W4CLY	12	5	720
W4JHC	12	5	720
W4OLK	12	5	720
W4FJ	12	5	700
W4UMF	12	5	600
W4LRR	5	2	900
W5JTI	14	5	670
W5RCI	14	4	790
W5QNL	10	5	1400
W5CVW	10	2	1180
W5MWW	9	4	570
W5AJG	9	3	1260
W5ML	9	3	700
W5ERD	8	3	570
W5ABN	8	2	780
W5VX	7	4	—
W5VY	7	3	1200
W5FEK	7	2	580
W5ONS	7	2	950
W5SWV	7	2	—
W5FBT	6	2	500
W5IRP	6	2	410
W5FSC	5	2	500
W5DFU	5	2	275
W6PJA	3	3	1300
W6ZL	2	2	1400
W6W5Q	2	2	1390
W6NLZ	2	2	237
W6GCG	2	2	210
W6EXH	2	2	193
W6ZEM/6	1	1	415
W6GGM	1	1	300
W6YYG	1	1	300
W8WJC	21	7	775
W8BFQ	21	7	775
W8WRN	19	7	670
W8WXV	18	8	1200
W8UKS	18	7	720
W8DX	17	7	675
W8EP	17	7	—
W8WSE	16	7	830
W8RWW	16	7	500
W8BAX	15	6	655
W9FVJ	22	7	850
W9EQC	21	8	820
W9BPV	20	7	1000
W9UCH	20	7	750
W9LF	19	—	—
W9WOK	17	6	600
W9MBI	16	7	660
W9BOV	15	6	—
W9ZHL	15	6	—
W9LEE	14	5	780
W9FAN	13	—	680
W9UIA	12	7	540
W9GTA	11	5	540
W9JBF	10	5	760
W9DSP	10	4	700
WØEMS	21	8	1175
WNØGUD	20	7	1065
WØIHD	16	6	725
WØNFM	14	7	660
WØZJB	12	7	1097
WØINI	12	5	830
WØWGZ	11	5	760
WØOAC	11	5	725
WØJHS	9	3	—
WØHXY	9	3	—
VE3AIB	17	7	850
VE3DIR	14	7	790
VE3BPB	12	6	715
VE3AQG	11	7	800
VE1QY	11	4	900
VE3DER	10	6	800
VE3BOW	8	5	520
VE3QN	7	3	540
VE3TN	7	4	480

Photo 12. By July 1953 Jim was at the top of the 2-meter standings as published in QST. *This shows some familiar calls, including W2AZL and W2UK.*

Photo 13. In 1954, Tommy Thomas, W2UK, and Paul Wilson, W4HHK, in Tennessee, were credited with the first-ever meteor-scatter QSO on 2 meters. In an effort to pick up Tennessee as a new state, Jim created the new 48-element antenna shown here.

same place that helped perfect the cavity magnetron years earlier. He even got to set up and describe the operation of a vintage SCR-268 radar unit to Bell Labs employees at Whippany.

Jim described how the first DEW line equipment had to be brought up to Canada by boat, then towed to the DEW line site using Caterpillar tractors that resembled a train going over the snowy landscape. DEW line training was done in Streator, Illinois, where a simulator station was built for training and equipment testing purposes. Jim's work involved vehicular communications, something that his W.E.R.S. experience no doubt prepared him for. An interesting communications problem that Jim worked on was unique to the Arctic environment—snow and ice static. Jim's solution was as effective as it was simple: Place the antenna elements inside plastic tubing! Another problem that Jim recalls, but was not personally involved in, was that of geese setting off the radar alarms!

Moonbounce, the 1950s

In the early 1950s, some of the more ambitious amateurs were looking to the moon as a reflector of their 2-meter signals. That this was even possible was first demonstrated in 1946 by the U.S. Army at Camp Evans, also in NJ. Using modified SCR-271 radar equipment, not unlike the familiar SCR-268 that Jim had worked on years earlier, the Army first detected echoes off the moon using military power levels. In 1953, two amateurs, W4AO and W3GKP, used stacked rhombics to detect the first amateur echoes off the moon using amateur power levels. At about the same time, Jim started working on long, long Yagis, impressive structures up to 40 feet long in some cases. When Jim discovered that a West Coast ham, Herb Johnson, W6QKI, was also working on such 2-meter designs, they decided to team up, comparing test results and verifying one another's work. Their classic article on the subject ("LONG Long Yagis") appeared in the January 1956 issue of *QST* and is perhaps responsible for the tremendous interest in Long Johns at that time, especially for those interested in moonbounce. Jim recalls

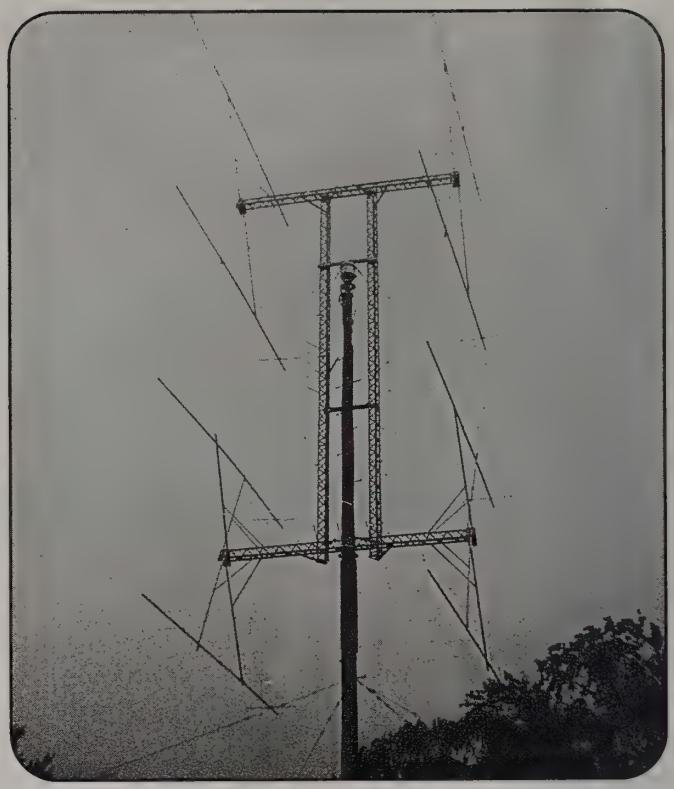


Photo 14. Jim's 2 over 4 moonbounce array in 1956.

how he and Herb together worked out many different designs, each with certain advantages. Then Herb, who worked for Gonset at the time, took their best design and made it into a commercial offering. Ralph Thomas, KH6UK, called this antenna "Big Bertha," and he appears to have used some while living in Kahuku, Hawaii.

In 1956 Jim and Herb embarked on Project "Jersey Bounce," an attempt to communicate coast to coast via the moon. Jim started with an array of four Long Johns, arranged 2 over 2, and later went to eight Long Johns, arranged 2 over 4. Photo 14 shows Jim's 2 over 4 moonbounce array in 1956.

As impressive as John's array was, Herb's array of 16 Long Johns mounted 8 over 2 was even bigger. Photo 15 shows the array supported by a wooden A frame.

When Jim reported hearing his own echoes off the moon in 1957, he started recording them. In an interesting experiment Jim pulsed his transmitter on and off, sending a single pulse every 5 seconds and listening for echoes in between. In one session, Jim succeeded in hearing 30 out of 120 pulses. He recalls how he thought someone was playing a joke on him, but when he adjusted his antenna azimuth he could see how the signal strength would change. In his book *The Exploration of Outer Space* first published in 1962, astronomer Sir Bernard Lovell described a similar experiment performed by radio astronomers using some of the largest radio telescopes at the time:

Ten years ago it was a difficult technological problem to transmit radio waves from earth and pick them up again $2^1/2$ seconds later after they had been reflected from the surface of the moon nearly a quarter of a million miles distant. Now, with the large radio telescopes, this is an easy technical task but, as so often happens with new scientific experiments, completely unexpected effects were encountered. The moon appears to be fairly uniformly bright to the eye, and it was assumed that if radio waves of uniform strength were transmitted to

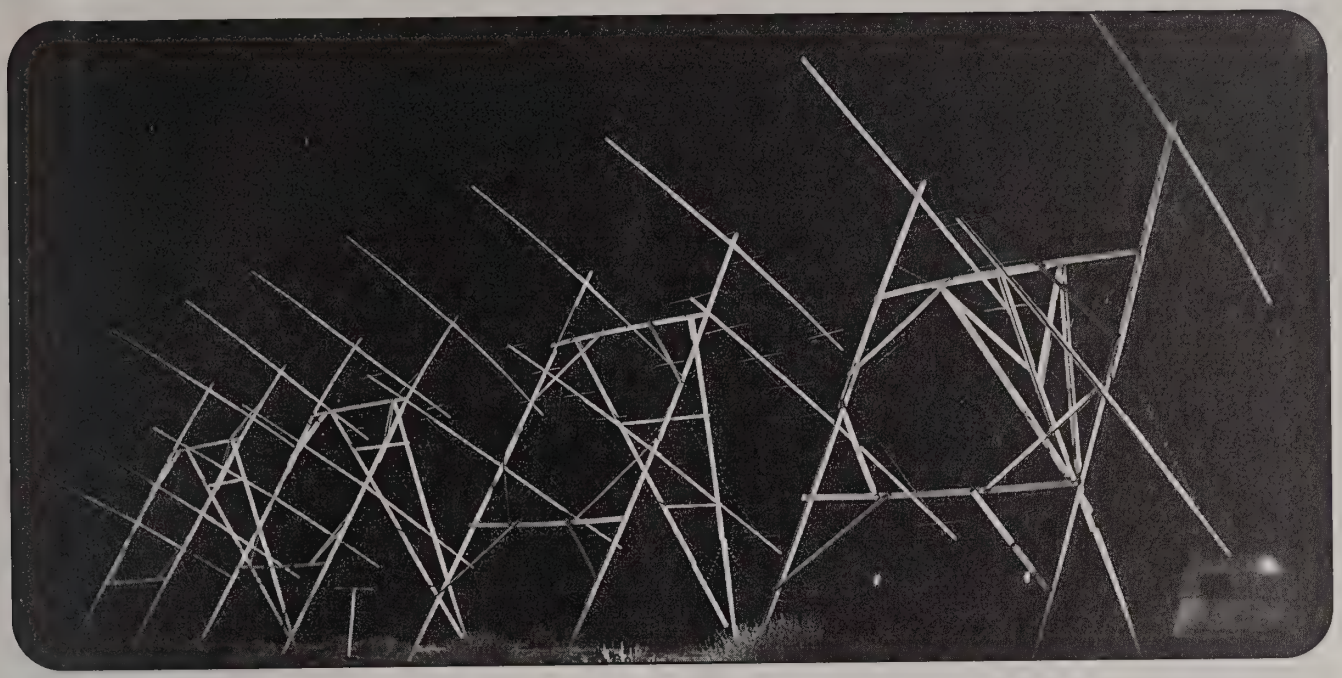


Photo 15. Jim's array supported by a wooden A frame. When Jim reported hearing his own echoes off the moon in 1957, he started recording them.

the moon, they would be scattered uniformly from the lunar surface so that the signal collected by the radio telescope and recorded as echoes on a cathode ray tube would always be of the same strength. It was surprising to find that this was not the situation. The transmissions from the telescope were made in the form of short pulses which were expected to be recorded as pulses of uniform strength after scattering from the lunar surface. In fact, very marked irregularities in the strength of the returned echoes were found. The individual pulses, separate in time by a second or so, varied in strength ... this fading is an effect of the libration of the moon.

In a way, Jim's experiment put him in a class with the best radio astronomers of the day, using equipment that he made himself! Jim sent a copy of his moon echo tape to Herb Johnson, W6QKI, in California. In a letter from Ralph Thomas, KH6UK, to Walt Morrison, W2CXY, that same year, Tommy remarked that John Chambers, W6NLZ, had heard Jim's tape and considered it good enough for a QSO.

Although both sides reportedly could hear their own echoes, a windstorm dashed all hopes of success as the California array was reduced to a pile of rubble. Photo 16 shows the "obituary" that Jim received shortly thereafter.

In September 1958, VHF pioneer Ralph Thomas, KH6UK, reported to Walt Morrison, W2CXY, that he was going to rebuild his 4 over 2 Long John array into a 2 over 4 configuration. This would have been very similar to Jim's array with the exception of it being tiltable. Perhaps Tommy was inspired by the reports of Jim's echoes from the West Coast gang with whom he was keeping schedules, not to mention the glowing reports in *QST* at the time.

The Latter Years

Unfortunately, when Jim moved from Oak Tree back to South Plainfield in 1979, it was not a favorable location for antennas and so he couldn't get back on the air. In that last move many of Jim's QSLs and audio tapes were lost, including that now famous moonbounce tape. All that remains of Jim's many years in VHF radio are his sharp memory, a few binders containing vintage QSLs, and a looseleaf scrapbook lovingly kept as a reminder of his "40 years of ham radio." Although the memories are all wonderful, one stands out in particular for the VHF enthusiast. Tucked away on page 43 of his scrapbook is a card that speaks volumes of the fraternity that existed among the VHF pioneers back then. That card, shown in photo 17, commemorates not only the 25th anniversary of Jim's historic meteor-scatter QSO with Paul on August 14, 1954, but also the long-time friendship that existed among VHF men as well as their families during the golden age of VHF radio. Imagine receiving such a card from someone you first met 25 years ago!

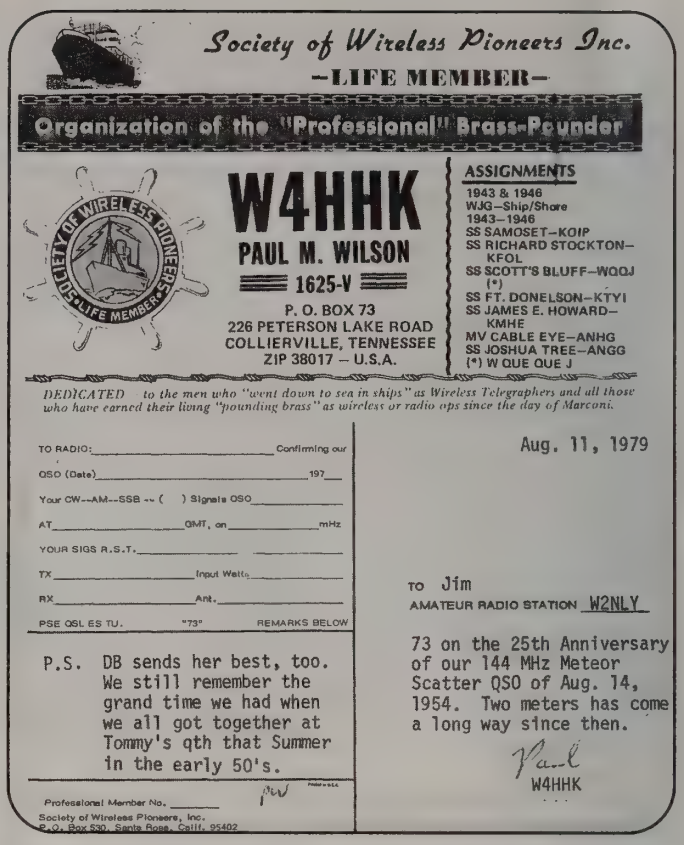
Oct. 24, 1956

At approximately 3 a.m. this morning the 208 element Moonbeam at San Fernando, Calif. was struck with a severe attack of violent air pressure and was mortally stricken. She fought bravely up until 7 a.m. when the end finally came. Her loss is felt deeply by all concerned with Project "Jersey Bounce". Services will be held at the home of K6EYN on Oct. 27. Burial will be handled by the V.H.F. Rubbish Removal Co. Please omit flowers. Hammers, saws, wrecking bars and muscle will be appreciated.

Pallbearers are: K6EYN, K6OUK, K6IVO, W6 ZAT, W6QKI, W6QED, W9QEP/6, W9QXP/6, and W2YPY/6. Pallbearer in absentia: W2NLY.

Photo 16. Jim sent a copy of his 1957 moon echo tape to Herb Johnson, W6QKI, in California. In a letter from Ralph Thomas, KH6UK, to Walt Morrison, W2CXY, Tommy remarked that John Chambers, W6NLZ, had heard Jim's tape and considered it good enough for a QSO. Although both sides reportedly could hear their own echoes, a windstorm dashed all hopes of success as the California array was reduced to a pile of rubble. This is the "obituary" that Jim received shortly thereafter.

Note the last line on the card where Paul says, "Two meters has come a long way since then." Jim remarked how much 2 meters has changed even since then, with moonbounce now being possible using modest power and single Yagis with gains on the order of his own designs. I mentioned how some people challenge the newer modes for moonbounce communication based on not being able to hear the signal. To this Jim replied, "Yes, but you can see it!" In any case, moonbounce by any means is an exciting prospect.



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PSE QSL ES TU. "73" REMARKS BELOW

P.S. DB sends her best, too. We still remember the grand time we had when we all got together at Tommy's qth that Summer in the early 50's.

Professional Member No. _____
Society of Wireless Pioneers, Inc.
P.O. Box 530, Santa Rosa, Calif. 95402

Aug. 11, 1979

TO Jim
AMATEUR RADIO STATION W2NLY

73 on the 25th Anniversary of our 144 MHz Meteor Scatter QSO of Aug. 14, 1954. Two meters has come a long way since then.

Paul
W4HHK

Photo 17. This card commemorates not only the 25th anniversary of Jim's historic meteor-scatter QSO with Paul, W4HHK, on August 14, 1954, but also the long-time friendship that existed among VHF men as well as their families during the golden age of VHF radio.

I mentioned to Jim how all the articles on early meteor scatter invariably mention the same four calls; W2UK, W2AZL, W2NLY, and W4HHK. This got me to wondering if Tommy, Carl, and Jim might have been good friends. Jim answered with a simple story about a time when he, Tommy, and Carl were driving across Pennsylvania in the early 1950s and apparently having a really good time, when all of a sudden a police car pulled Tommy over for speeding. I can just imagine the three of them, all legends in their own right, traveling through Amish country, scoping out antenna locations and just having fun.

Since Jim has been off the air for a few years, I asked him if he had any hobbies other than ham radio. He replied, "No, it's all about family," as he pointed to some pictures in the front hallway. I like to think that's the way it's always been for Jim, from those early days at Hadley with his dad, to the time he and his father worked together on the South Plainfield W.E.R.S. station, to his immediate family, and to his amateur radio family. It's always been about family. I hope that by reading this, both his personal as well as ham radio family will come to recognize Jim as what he really is—a pioneer in the family. That's not something you can say about many people nowadays.

I would like to thank Jim for sharing all his wonderful memories and pictures with us. I will always consider it a great privilege to have met Jim and an even greater honor to have brought his story to the next generation of pioneers. ■

QUARTERLY CALENDAR OF EVENTS

Current Contests

June: ARRL June VHF QSO Party. The dates for this contest are 13–14 June. Complete rules are in the May issue of *QST*. Rules can also be found on the ARRL website (http://www.arrl.org). Many are making plans to activate rare grids. For the latest information on grid expeditions, check the VHF reflector (vhf@w6yx.stanford.edu) on the internet. For weeks in the run-up to the contest postings are made on the VHF reflector announcing rover operations and grid expeditions. It is a contest that will create for you plenty of opportunities to introduce the hobby to your friends who are not presently working the VHF plus bands or who are not hams.

SMIRK Contest. The SMIRK 2009 QSO Party, sponsored by the Six Meter International Radio Klub, will be held from 0000 UTC June 20 to2400 UTC June 21. This is a 6-meter only contest. Exchange SMIRK number and grid square. Score 2 points per QSO with SMIRK members and 1 point per QSO with nonmembers. Multiply points times grid squares for final score. Awards are given for the top scorer in each ARRL section and country. Logs and log requests should be sent to: David Craig, N3DB, 4931 Mariners Drive, Shadyside, MD 20764 USA. Logs may also be submitted via electronic mail to <davidhcraig@verizon.net> and must be received no later than 1 August, 2009. For more information see the URL <http://www.smirk.org> and click on the SMIRK Contest link at the top of the page.

Field Day. ARRL's classic, Field Day, will be held on June 27–28. Complete rules for this contest can also be found in *QST* and on its website: <http://www.arrl.org>. In years past tremendous European openings have occurred on 6 meters. Also, as happened in 1998, very large sporadic-*E* openings can occur. Certainly, this is one of the best club-related events to involve new people in the hobby.

July: CQ WW VHF Contest. This year's CQ WW VHF Contest will be held from 1800 UTC July 18 to 2100 UTC July 19. The rules for this contest can be found in the June issue of *CQ* magazine and on the *CQ* website: <www.cq-amateur-radio.com>

August: There are two important contests this month: The **ARRL UHF and Above Contest** is scheduled for 1–2 August. Complete rules can be found in the July issue of *QST*. The first weekend of the **ARRL 10 GHz** and above cumulative contest is scheduled for August 15–16. The second weekend is September 12–13. Complete rules for this contest also can be found in the July issue of *QST*.

Current Conferences and Conventions

May. Dayton Hamvention®. The Dayton Hamvention® will be held as usual at the Hara Arena in Dayton, Ohio, May 15–17. For more information, go to: <http://www.hamvention.org>.

June. The annual **Ham-Com Hamfest** will be held June 12–13, 2009, in Plano, Texas. As always, the North Texas Microwave Society will present a microwave forum. For more information, see the Ham-Com website at <http://www.hamcom.org/>.

July. This year's **Central States VHF Society Conference** will be held in Elk Grove, Illinois, July 23–25, at the Elk Grove Village Holiday Inn Hotel. For more information, please see the URL: <http://www.csvhfs.org/>.

Quarterly Calendar

The following is a list of important dates for EME enthusiasts:

May 1	Moon first quarter
May 5	*Eta Aquarids* meteor shower
May 9	Full Moon
May 14	Moon apogee
May 17	Moon last quarter
May 24	New Moon
May 26	Moon perigee
May 31	Moon first quarter
June 7	Full Moon
June 10	Moon apogee
June 15	Moon last quarter
June 21	Summer solstice
June 22	New Moon
June 23	Moon perigee
June 29	Moon first quarter
July 7	Moon apogee
July 7	Full Moon
July 7	Lunar eclipse
July 15	Moon last quarter
July 21	Moon perigee
July 22	New Moon
July 22	Solar eclipse
July 28	*Southern Delta Aquarids* meteor shower
July 28	Moon first quarter
August 4	Moon apogee
August 6	Full Moon
August 6	Lunar eclipse
August 12	Perseids Meteor Shower
August 13	Moon last quarter
August 19	Moon perigee
August 20	New Moon
August 27	Moon first quarter
August 31	Moon apogee

—EME conditions courtesy W5LUU

Calls for Papers

Calls for papers are issued in advance of forthcoming conferences either for presenters to be speakers, or for papers to be published in the conferences' *Proceedings*, or both. For more information, questions about format, media, hardcopy, e-mail, etc., please contact the person listed with the announcement. The following organization or conference organizer has announced a call for papers for its forthcoming conference:

Central States VHF Society Conference: Technical papers are solicited for the 43rd annual Central States VHF Society Conference to be held in Elk Grove, Illinois on July 23–25, 2009. Papers, presentations, and posters on all aspects of weak-signal VHF and above amateur radio are requested. You do not need to attend the conference, nor present your paper, to have it published in the *Proceedings*. Posters will be displayed during the two days of the conference. Non-weak signal topics such as FM, repeaters, packet radio, etc., generally are not considered acceptable. However, there are always exceptions. Please contact the folks below if you have any questions about the suitability of a topic. Strong editorial preference will be given to those papers that are written and formatted specifically for publication, rather than as visual presentation aids. Submissions may be made via the following: electronic formats (preferred); via e-mail; uploaded to a website for subsequent downloading; on media (3.5" floppy, CD, USB stick/thumb drive). Deadline for submissions: For the *Proceedings*, June 1; for presentations to be delivered at the conference, June 29; and for notifying them that you will have a poster to be displayed at the conference, June 29. Bring your poster with you on July 23 or 24. Contact information: Kermit Carlson, via e-mail: <w9xa@yahoo.com>, or snail mail: 1150 McKee St., Batavia, IL 60510.

Technical papers are solicited for presentation at the **28th Annual ARRL and TAPR Digital Communications Conference** to be held September 25–27 in Chicago, Illinois and publication in the conference *Proceedings*. Presentation at the conference is not required for publication. Submission of papers is due by July 31 and should be submitted to: Maty Weinberg, KB1EIB, ARRL, 225 Main Street, Newington, CT 06111, or via the internet to <maty@arrl.org>. For suitable topics and submission guidelines also contact Maty via e-mail; also check <http://www.arrl.org>.

Meteor Showers

May minor showers include the following and their possible radio peaks: η-*Aquarids*, May 6, 0000 UTC; ε-*Arietids*, May 9, 0800 UTC; May *Arietids*, May 16, 0900 UTC; and *o-Cetids*, May 20, 0800 UTC.

June: Between June 3 and 11, the *Arietids* meteor shower will once again be evident. This is a daytime shower with the peak predicted to occur on June 7, around 1100 UTC. Activity from this shower will be evident for around eight days, centered on the peak. At its peak, you can expect around 60 meteors per hour traveling at a velocity of around 37 km/sec (23 miles per second).

On June 9 the *Zeta Perseids* is expected to peak around 1100 UTC. At its maximum, it produces around 40 meteors per hour. The *Boötids* is expected to make a showing between June 27 and July 2, with a predicted peak on June 27, around 0830 UTC. On June 28 the *Beta Taurids* is expected to peak. Because it is a daytime shower, not much is known about the stream of activity. However, according to the book *Meteors* by Neil Bone, this and the *Arietids* are two of the more active *radio* showers of the year. Peak activity for this shower seems to favor a north-south path.

July: This month there are a number of minor showers. The *Piscis Austrinids* is expected to peak July 28. The δ-*Aquariids* is a southern latitude shower. It has produced in excess of 20 meteors per hour in the past. Its predicted peak is around July 27. The *Piscis Austrinids* is expected to peak around July 28. The α-*Capricornids* is expected to peak on July 30.

August: Beginning around July 17 and lasting until approximately August 24, you will see activity tied to the *Perseids* meteor shower. Its predicted peak is around 1730–2000 UTC on August 12. A possible tertiary peak may occur around 0900 UTC. The κ-*Cygnids* meteor shower is expected to peak on August 17. The visually-impossible γ-*Leonids* is expected to peak August 25, around 1000 UTC. The α-*Aurigids* is expected to peak on August 31.

For more information on the above meteor shower predictions see Tomas Hood, NW7US's propagation column. Also visit the International Meteor Organization's website: http://www.imo.net/calendar/2009.

VHF/UHF Weekly Net Successes

Many weak-signal nets continue to grow and flourish, where others struggle to stay alive. Here WB6NOA tells the story of John Kountz, KE6GFF, who makes a weekly trek to a hilltop overlooking Laguna Beach. From this QTH he regularly reaches out over 300 miles!

By Gordon West,* WB6NOA

Kenwood, Yaesu, and ICOM deserve credit from the VHF/UHF ham community for their small high-frequency transceivers, including multimode capabilities on 6 meters, 2 meters, and 440 MHz. It was not so many years ago when an HF rig did just that—high frequency, 3–30 MHz! Six-meter enthusiasts campaigned long and hard for 50–54 MHz multimode and were singularly impressed when the ICOM IC-706 and Yaesu FT-100 included 6 meters, *plus* 2 meters and 440 MHz, multimode! Kenwood soon followed with the TS-2000, with yet one additional band option, 1.2 GHz.

Those of us running VHF/UHF weak-signal nets continuously encourage HF operators to put up a modest horizontal antenna and try out the world above 50 MHz.

"During our 2-meter and 440-MHz weak-signal sideband nets, I regularly switch over to a vertically polarized omni antenna and welcome aboard an HFer or two who might be curious to see what is happening on sideband at the bottom of these VHF/UHF bands," commented Bill Alber, WA6CAX, north of the San Francisco, California, bay area.

Bill's close friend, Larry, W6OMF, may also use the same technique, and his Sunday evening bay-area 144.250-MHz weak-signal net draws over a hundred check-ins! Yes, his location . . . location . . . location . . . gives him a nice shot to more than 10 grids, and his four-bay of 2-meter long boomers reaches out over 400 miles away, but on the air he has something going that weekly magnetizes regular and brand-new check-ins for a signal exchange.

Sharing this unique magnetizing skill (which I will describe shortly) in southern California is 432.120-MHz net control John Kountz, KE6GFF, well known for his 432 weak-signal net success, plus his multiple DX adventures to Afghanistan *(see the article "The Responsible Person: Bringing Amateur Radio Back to Afghanistan, by John Kountz (T6EE/KE6GFF), March 2008* CQ *magazine)*. John's success on 432 MHz requires a rigorous off-road half-hour drive to get to location, location, location!

"My home QTH is nestled in a Laguna Beach canyon, a stone's throw from the news events you read about with fires and landslides," commented John, KE6GFF. "I take my 1967 vintage rebuilt Land Rover and get onto a closed fire road between the top of the world and Moulton Meadows Park. I have the key to the gate because I'm the local emergency communications ham radio contact to the city," said John with a smile.

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John Kountz, KE6GFF, getting ready to set up for his weekly 70-cm net at his hilltop location in Laguna Beach. (Photos by WB6NOA)

I rode with him one evening to the top of the 1000-foot hill with a clear view 360 degrees with no 432 obstructions. "Step to your left, Gordo, and that tarantula won't climb up your leg," commented the cool, calm, and very collected John.

John easily captured between ten and twenty 432-MHz check-ins almost immediately with his semi-homebrew 17-foot boom, K1FO, 25-element horizontal beam. It snaps together in 38 seconds, and there is no fiddling, with the insulated elements held perfectly in place with keepers.

"Laddie, N8EWU, provided the 3 1/6th material for the elements, and Mike, K6MYC, of M^2, swaged and drilled the boom

Rear view of the Land Rover used for KE6GFF's portable hilltop QTH. Kountz reaches out over 300 miles on many nights at this hilltop location, thus providing new operators a state away with predictable DX!

to my dimensions, and if it takes more than 45 seconds to get this 25 footer in place, something's wrong!" added John.

His mast can go up 28 feet and locks into a chain-driven, motorized mount firmly attached to the Land Rover with an upper support arm.

"My mast sections are several socketed pole-vault tubing pieces held together with Velcro™ and mounted via strap hinges to the ladder on the rear of my 109-inch '67 Land Rover," added John.

John flexed his elderly muscles and said he's tired of standing in the rain for "armstrong" rotation, so he contrived the chain-drive rotor which has reduced the number of reported head colds he has suffered after each Thursday mountaintop net event.

His rig is a vintage Yaesu FT-790 driving a TE Systems 100-watt amp, and depending on expected band conditions, he can feed his antenna with 9913 flex, or LMR 600 flex, and for some real serious tropo ducting, Andrews 5/8-inch hard line. The rig runs on a 105-amp/hour deep-cycle battery maintained by a 75-watt Siemens solar panel on the roof of the Land Rover, and absolutely independent of the vehicle starting battery.

"I know I'm on a hill, but I still don't like to pop the clutch if I should accidentally kill my only starting battery," said John, quite insistent that he has never had to come back down the hill in the dark without the engine running!

Net Success Stories

OK, now for the Larry, W6OMF, and John, KE6GFF, VHF/UHF net success stories, and there are likely hundreds more throughout the country where a single ham operator draws huge attention to the under-utilized weak-signal portion of our VHF and UHF bands.

Even more important than location, location, location, and a big antenna system is the capability of a single operator to hold the net together every week and keep the number of check-ins up.

What Larry and John do, with net control, is to get everyone's attention by becoming fun characters on the air! They run the net with a smile, and if you have ATV, you can see it! The successful nets (plus, I'm sure, hundreds of others) start out with news of the past week's weak-signal activities, band-opening reports from selected big-signal operators, propagation predictions for the upcoming week, and after a fast-paced 10-minute news routine, they stay exactly on schedule and roll the net.

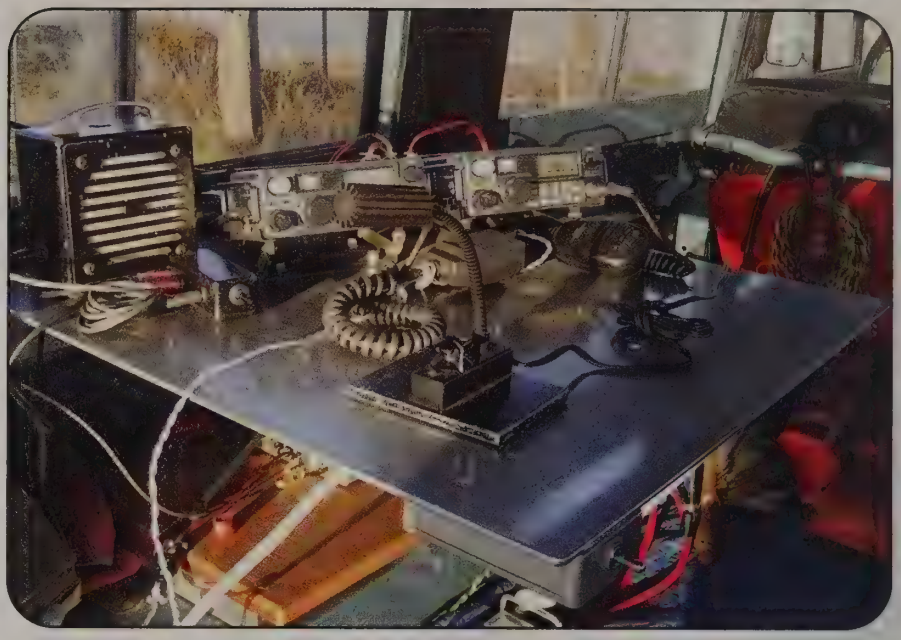
One approach, to a wide area net, has been adopted by Larry, W6OMF, and that

is to call specific stations known to be in selected 30-degree quadrants. Most know when their particular quadrant will be called, and there is usually an opportunity for missed and new check-ins to announce themselves before he swings away from that specific quadrant. John, on 432 MHz, does much the same thing, with distant, next-state-over stations knowing about when he plans to swing his beam in their general direction.

However, John and Larry have a unique technique that keeps both new and regular members coming back for more, every net week evening:

"Well, hi there, Jack, and no doubt you have Rosie sitting on your lap, and we all want to know how you got the long boomer to the tip of your mast without a gin-pole!" barks John, eliciting multiple responses from every station checking in, only now and then glancing at the scrawled notes he may have taken the week before.

"... Great signal from DM13, a nearly 300-mile shot down south, Sam. I hear the Hawaii beacon was in to So Cal last week, and if we imagined hard enough, we could hear some activity down on 144.170, coming across the pond. Did you make a Hawaii contact, Sam?" asks Larry.



The operating table for KE6GFF inside the Land Rover.

Both net controls manage these fun contacts and set the pace so a lengthy ragchew can't stall the net from going on to the next operator. Both of them regularly repeat the highlights, giving others well out of the area a heads up of how many southern California stations actually worked the 2500-mile path to Hawaii during a recent band opening.

"The professional lecturer will always repeat the question asked of him or her so everyone feels part of the discussion," commented Bill Alber, WA6CAX, retired from the teaching circuit.

Acknowledging stations with their callsign and their name give the operators a welcome feeling. By going further and asking that operator, by name, how last week's pet project is coming along, I can almost guarantee that the operator will be flattered that the net noticed and remembered the specific project, ensuring a return to the net the following week.

"WX6XYZ, you are 3 and 4 into the net, and you either have a problem with your mic cord, or your modulator stage is going south. Your signal is no good. Now who else was trying to get back to net control?" While this type of impersonal roll call may be suited for an emergency traffic net, the impersonal approach of barking on the net will probably cause newcomers, eager to check in, to back off from receiving a scathing signal report. "There is more to running a net than just exchanging callsigns," added another net controller on the East Coast.

No, I am not saying you have to be a *character* to run a weak-signal net. Even straight-faced, trying a little dialog with the other station just might make running a weak-signal net a little more personable.

Finally, if an unanticipated very weak-signal DX station should come on to the net during a tropo event that only occurs once a year, net control should encourage other stations who might be hearing this rare DX to make an exchange. As net control, even though you may have the biggest and best signal to this distant station, share the opportunity! If it's not a contest, take the time to tell the distant station that "Bernie, WX6YZX," is going to call him now.

It's rewarding to assist new weak-signal operators, with their new horizontal beams, to make that first big tropo contact right on the net. It makes you both feel good! Yes, this will slow down the net dramatically. However, I'll bet you will double the number of participants the next week.

This is fun! If your net has run out of steam, collaborate with another net controller on the same band and develop a new net with a good following. The whole idea is to increase our regular participation numbers on SSB and CW, plus weak-signal digital modes, to hold our own at the bottom of these bands.

Run your net with a smile! ■

The Story Behind the Book
Six Meters, A Guide to the Magic Band

The first edition of *Six Meters, A Guide to the Magic Band* was published nearly 15 years ago and was the first book dedicated to 6 meters. This article covers the story of its inception and subsequent editions.

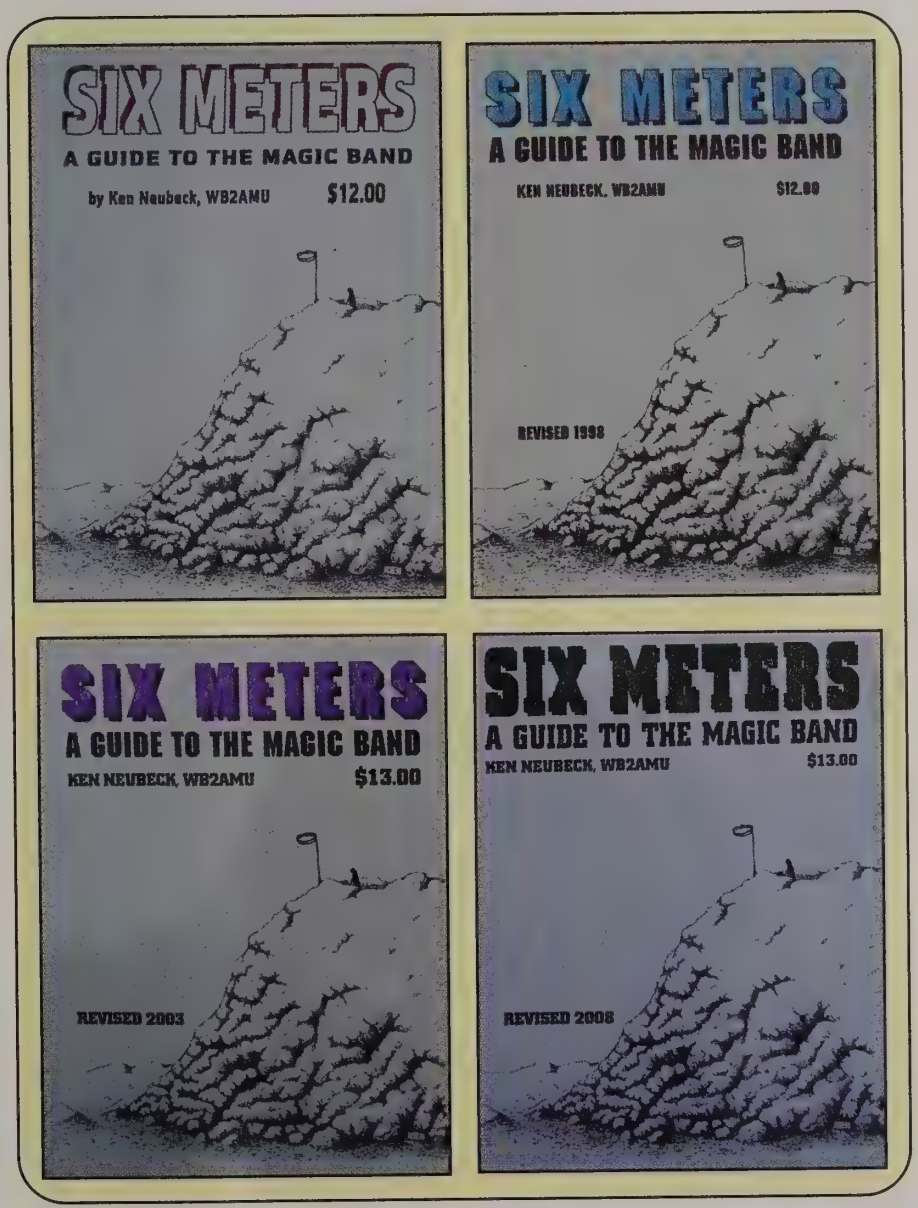
By Ken Neubeck,* WB2AMU

April 2009 will mark the 15th anniversary of the first edition of *Six Meters, A Guide to the Magic Band*, published by WorldRadio and the first book dedicated to 6 meters. Recently, the book underwent a fourth revision, its most complete version. This article covers the story of its beginnings and the various circumstances that led to the book.

Discovery of 6 Meters, The "Magic Band"

I became a ham in 1971, and I had always had a curiosity about the 6-meter band, but since most of the radios that were available were HF packages, I did not attempt it at that time. Also, I had heard that this band had particularly bad issues with TV interference, more so than the HF bands. I also remember finding the logs my father had from the 1960s that showed a contact he made with a VE5 station in Saskatchewan on 6 meters, and I wondered how he made a contact like that on a band that was supposedly used for local purposes such as Civil Defense work. Little did I know that I would eventually find out the answer some years later.

During August 1990, I was at a local flea market on Long Island, New York, when I came across a vintage Swan 250 6-meter transceiver. I took the plunge and was able to get the radio for $90. The deal included the radio, a microphone, and the operating manual, which included schematics. I was able to rig up a temporary antenna for the 6-meter band, but found little activity. Eventually, I found some local hams in the lower part of the band



The four editions of Six Meters, A Guide to the Magic Band *that were released in 1994, 1998, 2003, and 2008. (Photo by Ken, WB2AMU)*

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and they gave me a general primer as to where the activity was located. I set up a portable station in my back yard for the ARRL's September 1990 VHF contest and worked a couple of dozen stations via line-of-sight throughout the first day of the contest. However, I had to stop when a neighbor mentioned the next day that I was getting into his TV set.

Periodically I listened on that Swan 250 during the next few winter months, but found no activity on the band. There was not a lot of information about 6 meters from conventional sources, but it just a general overview about a propagation mode known as sporadic-*E*. I rigged up a vertical antenna for the January 1991 VHF contest and worked some line-of-sight stations, but it was not until the June 1991 VHF contest that I discovered the joys of the "Magic Band" and the mysterious propagation mode, sporadic-*E*.

During the first two hours of this contest on Saturday, the 6-meter band came alive with very loud signals and I worked a few dozen stations via sporadic-*E* from my home on Long Island into the deep south of the U.S. I could not believe the difference between the quiet band from which I had only heard line-of-sight stations and now was working many stations via skip! Then the band faded out after two hours and I thought that I wanted more. The next day, Sunday, the band was quiet until late evening, when Midwest stations from Minnesota came in, until I had to shut down because of TVI complaints from my XYL in our house. Throughout the rest of the summer, I caught a few more sporadic-*E* openings and worked a few DX stations, such as HH7PV in Haiti! In January 1992, I finally caught my first European opening and worked a number of western Europeans via *F2* propagation. Wow! During the course of the fall of 1992, I also heard my first aurora opening ever, and this too was another amazing revelation for me, when I heard distorted CW and SSB signals on 50 MHz.

I was hooked on these different propagation modes and started looking for every bit of information that I could find about 6 meters and also about both the sporadic-*E* and aurora phenomena. This included not only researching the ham literature, but also the scientific literature as well.

First, I started writing to hams who I was told knew a lot about the band, such as Tom Glaze, KC4SUS (now K4SUS), and Emil Pocock, W3EP. Emil was especially helpful, as he sent carefully typewritten letters about sporadic-*E*. (Remember that 1991 was before the internet and personal-computer phenomena really took off!) I also found out that 50.125 MHz was the important domestic calling frequency and 50.110 was the DX calling frequency. Tom Glaze was probably one of the first people who told me that 6 meters was also known as the "Magic Band."

Then I did research into what scientific literature was out there about the sporadic-*E* phenomenon, as well as the aurora phenomenon. This search eventually took me to the physics library of my alma mater, Stony Brook University, where I found scores of journals that had papers discussing sporadic-*E* and aurora. I found out that sporadic-*E* consists of ions that are compressed by wind-shear activity in the *E* region of the ionosphere. This collided with the theory presented by hams in past articles that sporadic-*E* was somehow weather related and correlated with thunderstorm activity.

Eventually I found that the published results from the rocket studies conducted during the 1960s had determined that the ions that made up the thin sporadic-*E* layers were metallic in nature, typically iron and magnesium, with origins traced to meteor ablation. Understanding the sporadic-*E* phenomenon was a significant key to understanding the major propagation mode that appears consistently on 6 meters on a yearly basis with a major summer season and a minor winter season.

Eventually, I realized that the Swan 250 was not going to serve me well in a practical sense if I was going to operate efficiently and often on the 6-meter band. The radio could not be cleaned up in terms of RF leakage, even with power reduction. Also, the radio had a tremendous drift problem, and the analog dial became unreliable at that point as to indicating where I really was on the band. I did a lot of searching and ended up purchasing a TS-670 quad-bander, a 10-watt radio that covered 40, 15, 10, and 6 meters. This radio solved a number of problems that I had with the Swan. It also allowed me to explore portable operations, because it could run off 12 volts. This would open up a new world for me as well, where I could be doing portable operations.

It became apparent to me that 6 meters was a fabulous band that hams had access to, but the information about it was very sketchy in the conventional ham radio sources and more information was needed to make hams aware of this interesting band. One problem that I noticed right away is that 50 MHz was always bundled up with all of the other VHF bands in VHF reference manuals. However, if you really come down to analyzing it, 6 meters is neither a pure-VHF band like 2 meters, nor is it a pure-HF band like 10 meters. It truly is a unique band that is the borderland territory between HF and VHF and stands out on its own. It seemed logical that the 6-meter band should be a topic covered all by itself in a major article, or in a book.

At this time in my life, I was doing a lot of writing in my job as well as writing about ham radio topics for various club newsletters, as well as a private newsletter that I circulated among friends known as the "Sporadic *E*." I then worked writing a short article for *QST* called "The Mysterious 6-Meter band," which was accepted for publication in the December 1992 issue, on my 40th birthday. In March of 1993, I wrote an in-depth article on sporadic-*E* and aurora propagation that was published in *WorldRadio*. But even more information needed to get out there about 6 meters and these propagation modes, but how?

The Book Becomes Reality

In the Spring 1993 issue of *WorldRadio* magazine, Publisher Armond Noble, N6WR, put out a request for hams to come up with some ideas on topics for books that could be published by WorldRadio, Inc. Immediately, I thought of an idea of a book dedicated to the 6-meter band and sent my proposal to Armond. With encouragement, I called Armond, and he told me that he had operated 6 meters from Wyoming in the late 1950s and had a lot of fun with the band. I immediately set out to work up an outline to do the project and start collecting material.

In 1993, there was a significant amount of information and material that I had to collect for this book project. I contacted Tom, KC4SUS, about the quad antenna that he used on 6 meters; Emil Pocock, W3EP, about different aspects of 6-meter propagation; and Frank, AA2DR, about vintage 6-meter radios and his amazing contact with Australia from Long Island on 6 meters in October 1992. In addition, Larry, WB5KYK, wrote back to my request for information with a major tutorial on meteor-scatter work on 6 meters.

Most of the book was written in May

1993. After getting some basic chapters done on propagation, equipment, and antennas, I integrated additional material that Frank, AA2DR, had spent significant effort in collecting regarding the interesting 6-meter equipment that was common during the 1960s. The antenna ads, particularly the Saturn Six Halo antenna really gave an esoteric feel to the book.

A major aspect that I wanted to convey in the book is the idea of having fun on 6 meters. This was promoted by the fact that different modes of propagation could occur at certain times on a normally quiet band and really change things. Also, because of the small wavelength of the band, portable operations to rare grid squares or to other countries were reasonably possible with modest effort and equipment.

Another important aspect of the book is that it was the published work that tied directly to scientific studies regarding sporadic-*E* and aurora propagation. A chart summarizes the results of various rocket studies that were conducted during the 1960s and 1970s, when the sporadic-*E* ions were determined to be metallic, typically iron and magnesium. Presenting scientific-based information in the book was a major step.

By late fall 1993, I had put together all of the material for the book and sent the final manuscript to Armond and his wife Helen. I realized that while the effort was pretty comprehensive, there was still some room for growth for future editions of the book.

The final form of the book clocked in at 80 pages. WorldRadio had planned on having copies available at the 1994 Dayton Hamvention®, which would coincide with an announcement in a sidebar of another 6-meter article that I wrote for the March 1994 issue of *QST*, "Getting Started on the Magic Band." However it took a bit longer, and the book came out in late April.

Opportunities

With the book being published in 1994, opportunities developed for me to speak about 6 meters at monthly amateur radio club meetings as well as ham radio conventions, and this has continued through the years. Things started changing after 1994, when more and more radios came out with HF plus 6 meters, or HF plus VHF packaged transceivers, with the ICOM IC-706 being one of the first in this group. The inclusion of 6 meters in these radios has led to a large influx of HF operators on the band, and they, too, have found many aspects of the band interesting.

Since the release of the 6-meter book in 1994, WB2AMU has been speaking about the topics covered in the book at different ham radio venues throughout the country. This photo shows Ken speaking about 6-meters at the recent PACIFICON ham convention that was held in San Ramon, California in October 2008. This was his first talk on 6 meters in California. (Photo by Fran Neubeck)

The first edition of the book sold out in early 1998. Since then there have been three more editions published by WorldRadio, each expanding the content. Many changes have occurred over the 15 years covered by the four editions of the 6-meter book in which the technology from the end of one century has changed with the arrival of the next.

I reflect back on the past 15 years and realize how lucky I was to have this opportunity to write about the band, as well the opportunity to meet many other 6-meter operators. I am eternally grateful to Armond and Helen Noble for the support they gave me. Also, I am grateful to all of those in the 6-meter community who responded to my request over the years for their input. AA2DR and K4SUS were a major source of information for the original book, and I am also grateful to Gordon West, WB6NOA, for his foreword used in later editions. I really hope that the 6-meter book has helped make this incredible band easier to understand and enjoy! ■

By Joe Moell,* KØOV

HOMING IN

Radio Direction Finding for Fun and Public Service

Ideas for Increasing Foxhunt Participation

"You're never alone when you're in a ham shack." Perhaps you remember those words by the late Roy Neal, K6DUE, in his narration of "The World of Amateur Radio," a promotional film from the late 1970s. For DXers, ragchewers, and contesters, a ham radio station can provide human contact when nobody is around, no matter where you are on the globe.

However, what if your favorite ham radio activity is hidden-transmitter hunting? Just like the game of hide-and-seek, that's not something you can easily do by yourself. How can you get others to join in the fun?

With a little luck, your family members may be interested in helping you test your RDF (radio direction finding) equipment by hiding a transmitter for you to find. That is what Nadia Scharlau and her husband Charles, NZØI, did in North Carolina as they trained for the 2006 ARDF World Championships in Bulgaria. "That summer, we would take a couple of transmitters to the park," Nadia recalls. "He would hide one transmitter and I would hide the other one. As soon as I would find his, I would move it. He would do the same and we would repeat five or six times. By then we felt dead because of the heat."

The next step for promotion is the local radio club. Two decades ago, Kevin Kelly, N6QAB, was an active mobile T-hunter in southern California, going on many of the All-Day Hunts (which often lasted all weekend) and taking videos with his vehicle-mounted "hunt cam." Then his employer transferred him to Albuquerque, New Mexico, where there had not been any transmitter-hunting activity for years.

Kevin wasted no time. He began talking up the sport on the local repeaters and at the Albuquerque Amateur Radio Club meetings. Before long, there were regular mobile T-hunts in the Duke City. Then

Encouragement by Kevin Kelly, N6QAB, brought a good turnout to the University of New Mexico campus for the start of this mobile T-hunt in 1995. (All photos by Joe Moell, KØOV)

At this on-foot foxhunting session at Topanga State Park in March 2009, nine hams assembled measuring-tape Yagis and attenuators and then tried international-rules ARDF for the first time. Marvin Johnston, KE6HTS (leaning over the big battery), provided the kits.

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e-mail: <k0ov@homingin.com>

A completed measuring-tape Yagi with offset attenuator mounted in the PVC pipe boom. With the 2-meter handi-talkie, it's ready for on-foot foxhunting.

Kevin was transferred to the East Coast, where he began the promotion process again. Meanwhile, RDF contesting was becoming so popular in Albuquerque that the club agreed to organize the First USA ARDF Championships in 2001. AARC hosted again in 2005 and continues its regular mobile and on-foot events to this day.

Don't hide your interest in transmitter hunting. Talk it up on the local repeaters. Write an article for the club newsletter.[1] Offer to give a program or an RDF equipment show-and-tell at a club meeting. If you don't think you can put together your own talk, consider the excellent DVD about ARDF by Gary Pearce, KN4AQ.[2]

Like the "Field of Dreams" philosophy, I believe that "If you hide it, they will come." Schedule a beginner hunt and announce it at the beginning of your talk. That will make everyone pay better attention, realizing that they will need the information you're presenting to do their best on the hunt. The more follow-up sessions you have, the greater the chance that "critical mass" will be reached. On the other hand, without any starter sessions, nothing can develop.

Lowering the Barriers to Entry

Some hams and potential hams may have an interest in RDF, but they need a little extra push. Perhaps they lack confidence that they can build their own RDF equipment or that they can master the techniques. With that in mind, Marvin Johnston, KE6HTS, and I have begun holding antenna building and testing clinics before each of our ARDF sessions in a park, which usually take place once a month.

In addition to kits for measuring-tape Yagis[3] and offset attenuators[4], ready to assemble, the park's picnic tables are furnished with tools and soldering irons. Putting together a one-piece Yagi/attenuator assembly takes only about an hour, and then it's time to connect it to a 2-meter hand-held or scanner and find the simple practice transmitters nearby.

As the newcomers are doing that, the local radio-orienteering experts are arriving and getting ready to go out on the main five-fox international-rules ARDF course. Many of the beginners, full of confidence after finding the practice foxes, will get some advice from the experts and then take on the main course themselves.

Our prehunt building sessions began last November and there has been a good turnout of newcomers every time. Our success has caught the attention of the vehicular RDF fans, too. Long-time mobile T-hunter Bob Thornburg, WB6JPI, attended our event at Bonelli Regional Park in February and became convinced that simple kits could reverse the sagging attendance at southern California mobile T-hunts.

Bob went home, booted EZNEC[5] on his computer, and came up with a simple 3-element Yagi that will withstand the rigors of mounting on a car or truck. EZNEC modeling showed that securing its feedline to the boom all the way back to the reflector would keep the gain and directional pattern excellent, regardless of the beam's orientation for polarization. That's important, because match-

Rob Preston, KI6KYX (left), and his dad Bill, KZ3G, built measuring-tape Yagis and offset attenuators at a recent park session in southern California.

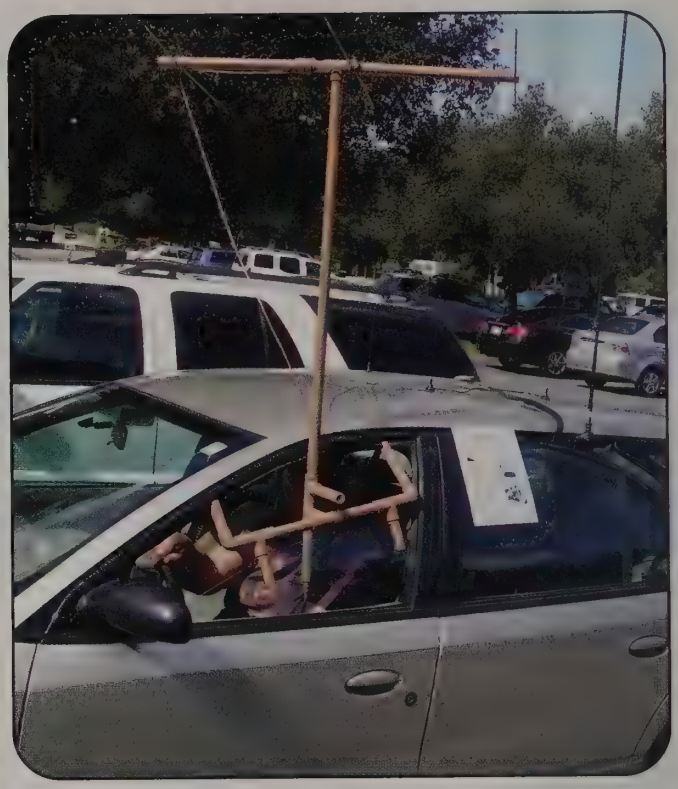
Hamvention® Foxhunt Forum Returns

Bob Frey, WA6EZV, needed a bullhorn to address the large group of participants in the Hamvention® foxhunt of 1999. There will be a Foxhunting Forum at the 2009 Hamvention®, but a foxhunt has not been scheduled as of press time.

By popular demand, this year's Dayton Hamvention® has scheduled a Foxhunting Forum. For many years, this annual forum drew a full room of hams, eager to hear the latest about both mobile T-hunting and international-rules radio-orienteering. Recently it has been absent from the schedule, but Dick Arnett, WB4SUV, reports that he and Bob Frey, WA6EZV, will co-chair the forum in 2009. The list of guest speakers includes Brian DeYoung, K4BRI. All three have participated in the USA ARDF Championships, as has Brian's teenage daughter Emily, K4MLE.

The Foxhunting Forum is scheduled for 1445 to 1545 hours on Friday, May 15. Check the Hamvention® schedule for location.

Joe, KØOV



Bob Thornburg, WB6JPI, brought a prototype of his simple 3-element T-hunting Yagi and mobile mount to a recent ARDF session to get comments and suggestions.

ing your VHF RDF antenna's polarization with that of the hidden transmitter gives you more precise direct bearings. It also minimizes false bearings from signal reflections.

Next, WB6JPI dreamed up a simple window mount using PVC pipe, cut to fit around the glass and frame. To complete the package, Bob kitted a toggle-switch resistive RF attenuator for closing in. It's similar to the one in my book,[6] but Bob thinks that 80 dB is plenty for mobile T-hunting with most VHF receivers. Thus, his model has fewer resistive sections.

Bob tested his system on some mobile hunts and he also used it for transmitting on one hunt. At this point, he has completed fabrication of five parts kits for beta testing. After optimizing his design based on user comments, he plans to have some in-the-park sessions for kit building, followed by simple mobile T-hunts. You can follow his progress on my website[7] and the Southern California T-Hunters site.[8]

Hunt Anytime

Local amateur radio internet mailing lists in several cities have been discussing a decline in mobile T-hunt activity. Gas prices below $4.00 per gallon have brought back some participants, but there is still concern about the old-timers fading away and fewer newcomers replacing them. There could be many reasons for the downturn. Some hams aren't available on the days and times of the hunts. Others don't like the hunt rules, wanting them to be either more stringent or more lenient. Newcomers may stay away because they don't have the self-confidence to compete against the local experts.

For these folks, a no-pressure hunt-anytime option is attractive. It was a regular activity of the Minuteman Repeater Association a decade ago. An e-mail would suddenly appear from one member of the group stating that the Boston Fox was on the air. The frequency and transmission rate were also given, as well as the deadline for finding it. The batteries would last for several days, so everyone could hunt for it when their schedules permitted. Some took bearings during their daily commute and errands, then hunted in earnest on a free evening.

Barry Fox, W1HFN, of Sterling, Massachusetts wants to bring back those days. (Yes, that's his real name!) "I was a real rabid foxhunter myself," he writes, "So I was quite disappointed when the local clubs lost interest in deploying their foxbox or letting anyone else do it. I decided to try to get the activity restarted by doing it myself. I bought a Squawkbox,[9] mounted it in a die-cast enclosure with a spike antenna, and started hiding it in nature preserves for others to find."

How is it going so far? "There has been some response from members of two local clubs, but nothing overwhelming," Barry reports. "One of our club members offered to hide it so I could find it. That was a very nice gesture on his part."

Bob Thornburg, WB6JPI, began his first southern California GeoHunt just before last Thanksgiving. He didn't publish any boundaries. All that anyone was told at first was to listen for an intermittent signal on 146.565 MHz, which is coordinated for transmitter hunting by the Two Meter Area Spectrum Management Association. It wasn't long before the first hunter announced he had found it, adding to the interest.

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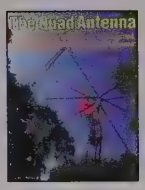

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After a February mobile T-hunt, Steve Wallis, WA6PYE, examines a resistive step attenuator prototype by WB6JPI.

The heart of GeoTran, as WB6JPI calls his hunt-anytime transmitter, is a 50-milliwatt Squawk-box, cycling 24 hours a day. It sends a 15-second enticement in Bob's voice every three minutes. A 1.5-watt solar panel[10] provides power, which is stored for cloudy days and nighttime in a 3-ampere-hour pack of nickel-cadmium batteries, the inexpensive type sold to radio-controlled car enthusiasts. The panel sits atop a copper-pipe J antenna. Transmitter and batteries are inside a rugged and weatherproof Pelican case.

Bob puts on a fresh GeoHunt every few weeks. A commotion ensues on the GeoHunt Internet Forum[11] as everyone tries to figure out where to hear the transmitter in southern California. After that, it's an individual effort as the participants mount their mobile RDF gear, track it down when they can, and sign in. Bob considers GeoHunt a success because it has brought out some new T-hunters and brought back a few who have not been on a regularly scheduled hunt for a long time.

Look Benign and Secure

Any item of electronics left in a public place becomes a magnet for vandals. After his first GeoTran was moved by persons unknown, Bob increased the unit's self-protection and security measures. So far, GeoTran II has not disappeared or suffered any damage.

Unattended hidden transmitters should look as non-threatening as possible. Ham radio news services recently gave much attention to the story from Omaha about a suspicious package, found in a partially burned home, which caused a neighborhood evacuation. After blowing it up, police learned that it was a trap for a ham radio antenna.

Not reported as widely was a similar story from a Washington, DC suburb, detailed in *The Gaithersburg Gazette* two weeks later. This time it was a "PVC pipe with wires coming out of it" and inside were "electronic components similar to those in a ham radio." Protect your investment and put a label on your hidden transmitter with your contact information.

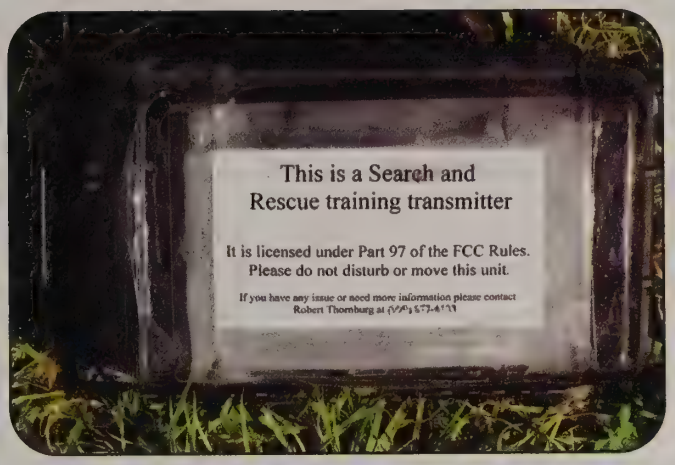
GeoFoxing Combines RDF and GPS

Although finding something unattended hasn't yet "gone viral" among hams, it certainly has among GPS owners. Just about every park, green belt, and wilderness area here in southern California has one or more geocaches within, attracting weekend visits from GPS-carrying persons of all ages. Geocaches are small containers filled with items for trade. GPS coordinates of caches are published on the web. More than once, I have had to explain to a ranger that our international-rules ARDF activities aren't the same as geocaching and that we won't be digging in the vegetation like some geocachers have done.

Hoping to take advantage of the geocaching craze, the North Bay Amateur Radio Club in California tried a combination game that they called GeoFoxing. Three temporary geocaches and two hidden transmitters were placed within the 72 acres of Youth Community Park in Santa Rosa. Participants were given geographical coordinates of Cache #1, which they located with their GPS receivers. There they found a tag with the frequency of Fox #1.

With their RDF gear, they tracked down that transmitter, whereupon they got the coordinates of Cache #2. At Cache #2, there was the frequency of Fox #2 and so on, until they got to Cache #3 next to the picnic lunch. This was a great way to introduce geocache fans to transmitter hunting and vice versa. Photos and more details of this event are at the NoBARC website <http://www.nobarc.com/activities/geofox/>. —*Joe, K0OV*

WB6JPI proudly stands beside GeoTran. Its solar panel is mounted atop a copper-pipe J antenna for 2 meters.



The GeoTran batteries and transmitter board are inside this heavy-duty plastic box.

GeoHunts started in southern California about the time that one of the regular weekend mobile T-hunts was discontinued. However, two monthly hunts on Saturday nights continue to have good attendance. One has "beginner" boundaries (radius approximately 13 miles from the starting point) plus requirements for one continuous transmission and closeness to a drivable road. The other has much larger boundaries (up to 40 miles from the start in some directions). It's not unusual for that one to have multiple transmitters with short transmissions, placed to require a considerable walk away from the vehicle.

The southern California "All-Day" hunts are still popular, too. With multiple transmitters and boundaries that permit just about any hidden location that doesn't require a seagoing boat to access, they can fill an entire weekend. If your club is just starting out, you will want to be much simpler than that. How about a brief hunt right after the weekly club repeater net?

From a hiding place, the fox makes frequent transmissions on the repeater input, urging every listener to get in the car and participate. It's best for the first hunt to have small boundaries, such as a county or part of it. After a while, help fledgling hunters by announcing yet smaller boundaries or giving other clues. Encourage members to pair up and to take ridealongs.

Your first mobile T-hunts should be easy enough that everyone is successful and encouraged. The signal should be strong and the transmitter should be in plain sight, perhaps in the parking lot of a restaurant or on a table in a city park. Give them a challenge, but don't make it "Mission Impossible." Some snacks for the fox finders would be nice, or everyone can get together for a meal or dessert at a restaurant afterwards.

After a few short hunt successes, everyone will be eager to try longer range hunts. On VHF/UHF, it's best to hold those on a simplex frequency, rather than tie up a repeater for long periods of time. Hiders will quickly learn to use tricks such as camouflage and controlled signal reflections.

A local park or school yard would be a good place for an all-on-foot foxhunt with little transmitters of 100 milliwatts or less. Imagine the fun of a dozen club members spread out in search of a half-dozen mini-foxes, all on different frequencies. How many can they find in a limited time period? Be sure that the kids, grandkids, nieces, and nephews of all members are invited. They don't need driver's licenses or ham licenses to receive and to hunt.

If the term "foxhunt" seems too intimidating, you don't have to call it that. This announcement appeared on the website of the Escondido Amateur Radio Society in California just before a *CQ*-sponsored Foxhunting Weekend: "EARS will be conducting a barbecue. Where is the barbecue you ask? That is for us to know and you to find out! The fox will begin transmitting on 146.595 on May 11 around 10 AM in the Escondido Area. When you find the transmitter, you will find the barbecue."

Head for Boston in June

Final preparations are now under way for the Ninth USA ARDF Championships near Boston on the first weekend of June. If you live in the northeast, this will be your first chance to attend our national championships of on-foot international-rules transmitter hunting without a long trip on the road or in a plane.

Foxhunting fans from all over the USA will gather at the Blue Hills Reservation, about ten miles south of downtown. We also expect participants to arrive from Sweden, Russia, Ukraine, Australia, China, and possibly some other countries, if visas can be arranged in time.

This year's USA championships are being combined with the biennial championships of International Amateur Radio Union Region 2 (IARU-R2), which encompasses North and South America. Radio-orienteers from Western Hemisphere nations will compete for IARU-R2 honors, while the others will compete as "visitors." There will be gold, silver, and bronze medals

in nine age categories, five for males and four for females, in accordance with standard IARU rules.

The championship courses will follow IARU standards. There will be five foxes on the air each day on the same frequency, 2-meter AM on Saturday and 80-meter CW on Sunday. Each transmits for one minute in rotating sequence, sending "MO" followed by a number of dits corresponding to the fox number, one to five. It's not necessary to know Morse code to tell which transmitter is on.

Competitors start at timed intervals and strive to find three, four, or all five of the foxes, depending on their categories. Then they rush to the finish, which is not in the same place as the start was. They find their way in the woods using a standard orienteering map, provided to them just before they start. They can also get help to the finish by tracking a transmitter there, which is on a different frequency in the same band.

Any person may enter the USA ARDF Championships if he or she is capable of safely navigating through the woods for five to ten kilometers. There is no age limit or requirement for a ham license. Contestants must provide their own RDF gear, which must not radiate any signals.

Organizing this year's championships is Boston resident Vadim Afonkin, KB1RLI. He won his first ARDF medal 25 years ago as a youth in his native Russia. His years of experience have made him an expert at championship-course design. Vadim will have assistance from members of the New England Orienteering Club, the Boston Amateur Radio Club, and other local organizations.

To encourage first-timers and overseas guests, the event entry fee will be waived for persons who are competing in the USA Championships for the first time and for persons arriving from outside North America. More information and registration forms are at the event website.[12] Plenty of lodging and meal options are available close by.

Vadim Afonkin, ex-UZ3AYT, wears a medal that he won at his first USA ARDF Championships near Cincinnati during 2003. He is now KB1RLI and has volunteered to be organizer and host for this year's national championships.

For a quick introduction to ARDF rules, techniques, and gear, visit my website at <www.homingin.com>. You will see equipment ideas for both 2 meters and 80 meters. Photo pages from previous championships will give you a good idea of what to expect in the woods of Massachusetts. Dress for high temperatures in the low 70s and a chance of rain.

I hope to see you there!

73, Joe, KØOV

Notes

1. My 1900-word article on mobile RDF titled "Transmitter Hunting, Southern California Style" at <http://www.homingin.com/SCalStyle.html> may be reprinted in ham club newsletters.
2. <http://www.homingin.com/video.html>
3. <http://home.att.net/~jleggio/projects/rdf/tape_bm.htm>
4. <http://www.homingin.com/joek0ov/offatten.html>
5. <http://www.eznec.com>
6. Moell and Curlee, "Transmitter Hunting — Radio Direction Finding Simplified," Chapter 6 <http://www.homingin.com/THRDFSinfo.html>
7. <http://www.homingin.com>
8. <http://www.thunter.org>
9. <http://www.silcom.com/~pelican2/PicoDopp/MICROHUNT.htm>
10. Harbor Freight 44768-4VGA <http://www.harborfreight.com>
11. <http://www.thunter.org/geothunt/>
12. <http://www.bostonardf.org>

By Bob Witte,* KØNR

FM/Repeaters—Inside Amateur Radio's "Utility" Mode

VHF FM Equipment for Emergency Communications

The subtitle of this column refers to FM as the *Amateur Radio Utility Mode*. This applies to everyday radio operating as well as emergency communications (EmComm). The combination of compact, portable transceivers and wide-area FM repeaters is very effective for supporting both short-term and long-term disaster communications.

This column discusses preparing your FM VHF/UHF radio equipment so you are ready for emergencies. It does *not* cover the all of the items you should have in your "Go Kit," which can include everything from food and clothing to reference documents and identification. (See the sidebar "What About My Go Kit?" for more ideas on that.)

Check in Locally

This is a general discussion of radio equipment, so it is important for you to connect with your local emergency communications group to understand its specific requirements. Of course, if you intend to be useful during a real emergency, you'll need to be working with these EmComm groups anyway well before an incident occurs. The most common emergency communications groups are the Amateur Radio Emergency Service (ARES) and Radio Amateur Civil Emergency Service (RACES). For more information on these organizations, see the ARRL Public Service Communications web page listed in the references section at the end of this column.

Some EmComm groups insist on having multiple bands available, usually 2 meters and 70 cm, while others just stick with 2 meters FM. Some groups make extensive use of digital modes such as APRS, Winlink and D-STAR, while others are focused only on voice. You'll want to make sure you have the right equipment and have the specific frequencies that your local group uses programmed into your rig. An emergency is a poor time to start fiddling with the memory in your radio.

Photo 1. The Yaesu FT-60R is a typical 2m/70cm handheld transceiver for emergency use. (Photo via rigpix.com)

Handheld Radios

Handheld transceivers (HTs) are just great little rigs with a ton of capabilities jammed into them (photos 1 and 2). Their excellent portability makes them an important tool for EmComm use. What other ham shack can you wear on your belt? However, while HTs excel at portability, they tend to have some significant limitations: low output power, poor antennas, and easily overloaded receivers. Other than that they are great!

The typical "full power" handheld transceiver has about 5 watts of output power. For EmComm use, I would generally avoid the smaller mini-HTs that only run 1 to 2 watts unless you intend to use them only for short-range communication within a building or around a camp site. Of course, we can increase the transmit power by using an external amplifier, but that will reduce portability and make the HT function more like a mobile rig.

A better approach is to upgrade the antenna, which improves both transmit and receive range. The standard rubber-duck antenna that comes with most HTs is a very poor radiator of RF energy. Changing the antenna to something larger will help immensely. Most amateur handhelds have a BNC or SMA connector on the antenna port, so the rubber-duck

Photo 2. The ICOM IC-92AD is a dual-band transceiver that has both analog FM and D-STAR modulation capability. (Photo via rigpix.com)

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e-mail: <bob@k0nr.com>

Photo 3. The single-band 2-meter FM transceiver is the workhorse of VHF EmComm. Shown here is the ICOM IC-2100H. (Photo via rigpix.com)

can be replaced with something that really radiates. Ideally, we'd have a telescoping antenna with a half-wave radiator, which does not require a ground plane underneath it (e.g., the MFJ-1714 Long Ranger antenna). I've tested a number of these antennas and have found their performance to be far superior to the standard HT antenna.

A common approach is to use an HT with a magnetic-mount mobile antenna and a 12-VDC cigarette-lighter power cord. This creates a compact station that can be deployed in almost any vehicle on short notice.

This brings us to the topic of battery power. Most often HTs are supplied with a single battery pack, usually with lithium-ion or NiMH technology. You'll want to have a spare battery pack or two for EmComm use; otherwise, you'll find yourself running out of power during an incident. One approach is to use a battery pack that accepts AA batteries and have a box full of AA batteries available. Some people prefer alkaline AAs, even though they are not rechargeable, because of their excellent shelf life. A package of alkaline AAs can be kept in your Go Kit for years without having to worry about charging them. A more environmentally friendly approach is to use NiMH rechargeable AAs, but you'll have to stay on top of keeping them charged.

Photo 4. A dual-band transceiver with two independent receivers provides a high degree of flexibility for emergency communications. (Photo via rigpix.com)

What About My Go Kit?

The main article discusses the radio communication needed in an emergency. Most emergency communicators keep a "Go Kit" on hand which includes radio gear and the other items necessary to support an effective communicator.

This can get complicated, as there are so many things that can be included in a Go Kit. The list greatly depends on your local geography, climate, weather, and likely communication scenarios. Check with your local EmComm group for its recommendations.

Here is a short list of items, just to get you thinking: Copy of amateur radio license, ARES/ RACES ID, lists of important phone numbers, ARES/RACES documentation, GPS, medications, writing instruments, notebooks, first-aid kit, maps, compass, binoculars, watch, cash, electrical tape, water bottle, spare clothing, sleeping bag, food, cooking equipment, orange safety vest, toilet tissue, toothpaste, toothbrush, flashlight, backpack, tools, SWR meter, digital multimeter, etc.

One issue that is easy to overlook is managing the transmit and receive audio. A speaker-mic is convenient for clipping onto your shirt near your ear so you can hear incoming calls without having the volume turned up too high. Even better is an earphone or headset. You may be deployed to a noisy environment where it is difficult to hear the radio, or you might be in a quiet spot where the served agency doesn't want to be distracted by radio chatter.

Mobile Radio

As much as I like a good-quality handheld transceiver, it is difficult to beat the performance of a full-power mobile transceiver. Most of these rigs have about 50 watts of RF power on 2 meters and usually a bit less on 70 cm. This extra punch is very useful for marginal communication paths. The receiver performance is usually quite good as well, tolerating a bit more interference from nearby transmitters and adjacent-channel noise sources. The downside is that you give up HT portability and you must provide a power source, either a 12-VDC power supply (running off AC) or a reasonably large rechargeable battery.

One key decision is whether to go with a single-band or dual-band radio (photos 3 and 4). I usually recommend a *true dual-band* transceiver, one that can receive two frequencies at a time. (Some dual-band rigs cover two bands but only one frequency at a time.) Even if you only plan to use the 2-meter band, it is very handy to be able to monitor two frequencies simultaneously. For example, you might listen to the primary net frequency on one receiver and use the second receiver to monitor a different frequency for coordinating local activity.

Just like with the HT, we need to plan for managing the audio. Most likely with a mobile transceiver you'll use the standard hand microphone for transmit. The internal speaker can be used for listening to the receive audio, but you may want to plug in a pair of headphones to block out noise or keep the radio traffic from disturbing others.

Antennas

The choice of antenna depends on the location involved and how portable the station needs to be. We've already talked about upgrading the antenna of a handheld radio. You may have to live with the low performance of a rubber-duck if you need

Photo 5. This VHF/UHF amateur radio station is an excellent example of how to organize a portable EmComm station. (Photo courtesy of NC6T)

to move around without any encumbrance, but it is still advisable to have a more efficient antenna available.

A versatile antenna for EmComm use is the magnetic mount mobile (either 1/4-wave or 5/8-wave). The reason is obvious: Just plunk this antenna on the metal roof of any vehicle and you are ready to go. Magnetic mounts can also be used as a temporary fixed antenna; stick it on the top of a refrigerator or filing cabinet. You need some metal underneath it, since the antenna performance depends on having a ground plane, but it doesn't need to be a perfect ground plane. Just use whatever is handy and see if it works!

The twinlead J-pole antenna is another popular portable antenna. This antenna is made out of TV twinlead feedline, creating a 1/2-wave radiator fed using a 1/4-wave tuning stub. These antennas perform well and do not require a ground plane. I won't go into the construction details here, as there have been many articles written about the fine points of building one of these antennas. (See the web page by KB3KAI listed in the references section.)

Another approach is to use a base antenna mounted on a portable tripod. A modest-size (maybe 5 feet in length, plus or minus) antenna such as the Diamond X-50A, Comet GP-3, or the Cushcraft AR-270 provides some gain while maintaining an omnidirectional pattern. For most situations, an omnidirectional antenna is most flexible, allowing communication in all directions without needing to rotate the antenna. There may

Photo 6. Rear panel of the portable station. (Photo courtesy of NC6T)

be times when it is useful to have a directional antenna with a bit more gain. You might find yourself stationed in a poor radio location, not able to hit the local repeater. Having a small Yagi that you can point toward the repeater (or another station via simplex) might be just enough to establish communications. There are many commercially available Yagi antennas available, or see the WA5VJB "Cheap Yagi" web page listed in the references to learn how to build your own.

Power Sources

Ensuring that we have a sufficient power source is critical for EmComm operating, since line power has a nasty habit of going away during disasters.

I've already mentioned having sufficient batteries for a handheld transceiver. Some radio amateurs deal with the power problem by using a humongous battery such as a 12-volt deep-cycle marine battery. When fully charged, these batteries can support a typical ham transceiver for several days, depending on how often you transmit. The obvious advantage is that this makes your radio equipment totally independent of AC power. Most amateur radio gear runs off 12 volts, naturally compatible with a 12-volt source. One problem you can run into is that some radio equipment does not work well when the battery voltage drops below 12 volts. Be sure to check out your radios to verify how long they last on a particular battery as it drops off in voltage.

The classic Field Day power source is the gasoline-powered AC generator. These generators can power a ham station almost indefinitely—at least until the fuel supply runs out. Having AC power available is especially handy for powering other equipment: computers, HT chargers, lighting, etc.

One final thought: You may be able to rely on a power source from the served agency. For example, our local fire department has a diesel generator for backup power to keep the fire station operational during power outages.

The NC6T Portable Station

Some hams have created a portable EmComm station by packaging their mobile transceiver, power supply and external speaker into an enclosure. Done correctly, this type of portable station can look very professional and leave a positive impression with the served agency. (On the other hand, hacking it together with duct tape will look like a second-rate installation.) A good example of a quality station is the one put together by Christopher, NC6T, shown in photo 5. This station has four radios packed into a portable 19-inch rack case. It has two single-frequency-at-time dual-band transceivers for 146 MHz and 440 MHz and a single-band radio for 222 MHz (top shelf). To support packet radio operations, there is a single-band 2-meter rig and a TNC (not visible in the photo).

Photo 6 shows the rear panel of this station, which is well organized and neatly constructed. Across the top are the antenna connectors, clearly labeled. The SWR meter has its connections brought out to the rear panel so it can be inserted in line to check the antenna system. While the station includes an Alinco power supply, Christopher also provided a means for powering the station from an external 12-VDC power source (see the Anderson Powerpole connectors at the lower right). At the lower left, the computer connections for packet radio are shown.

Other Gear

There are a number of other items that can be critical to effective emergency communications. It makes sense to *be prepared* for unexpected situations. Several lengths of coaxial cable with appropriate connectors will come in handy when it is time to install the antennas. A few coaxial adapters (PL-259 to BNC, BNC to SMA, etc.) are good to have along in case you need to adapt to someone else's equipment. Some basic test equipment such as an SWR meter and a digital multimeter can help troubleshoot unexpected problems. Some hams choose to carry a complete toolbox, but another option is to just carry the basics. One of the multipurpose tools from Gerber or Leatherman provides pliers, wire cutter, knife, and screw drivers in one compact tool.

For this article, I have not gone very deep into the digital modes, as each one would consume many pages. For transmitting large amounts of detailed data such as supply lists or detailed status reports, digital communication is faster and more accurate than voice methods. A number of EmComm organizations have adopted VHF packet radio (AX.25) as a means of transmitting digital data on VHF. As an alternative, APRS can be used for transmitting location information and short digital messages. The Winlink system, essentially a "radio e-mail" system, has proved to be very effective at routing messages in and out of a disaster area, passing e-mail messages onto the internet. D-STAR is gaining traction with some EmComm groups due to its converged approach to voice and data. For all of these systems, you'll want to find out what your local EmComm group is using and align with their communication plan.

Tnx and 73

As I wrap up this column, I realize that if you collect every piece of equipment mentioned in this article you'll have a truckload full of radio gear. Although there are some hardcore EmComm folks who do that, most of us will be equipped with a much smaller set of gear, so I don't want to imply that you need all of this equipment. Again, get in touch with your local EmComm group, find out what's in its communication plan, and tailor your plan accordingly.

Thanks for taking the time to read another one of my columns on the *Utility Mode*. I always enjoy hearing from readers, so stop by my blog at <http://www.k0nr.com/blog> or drop me an e-mail.

73, Bob, KØNR

References

ARRL Public Service Communications Manual: <http://www.arrl.org/FandES/field/pscm/>

ARRL Sections (to find ARES Emergency Coordinator): <http://www.arrl.org/sections/index.html>

Winlink System: <http://www.winlink.org/>

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D-STAR Amateur Radio (Wikipedia): <http://en.wikipedia.org/wiki/D-STAR>

Portable Roll-Up 2-Meter J-Pole Antenna, KB3KAI: <http://www.kb3kai.com/j-pole.php>

Kent Britain, WA5VJB, Cheap Yagi Antennas: <http://www.wa5vjb.com/yagi-pdf/cheapyagi.pdf>

By Bill Brown,* WB8ELK

UP IN THE AIR

New Heights for Amateur Radio

Kentucky Space Balloon-1

Last July 14th, Kentucky students from over six different colleges and universities launched a balloon payload dubbed Balloon-1 to the very edge of space from the Bowling Green, KY airport. The Kentucky Space program is a consortium of universities along with public and private organizations that collaborate to design and lead innovative space missions. The program allows a select group of students to design and build experiments that will end up on an orbiting spacecraft in the very near future (www.kentuckyspace.com).

Last July's Kentucky Space student payload carried APRS on 144.39 MHz; numerous still cameras for horizon, up, and down photos; and a low-power SAW transmitter circuit for CW telemetry on 434 MHz (see photo 1).

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Since one of the primary goals of this first flight for the Kentucky Space program was to demonstrate the use of high-altitude balloons for emergency communications, I included a simplex repeater payload on 144.34 MHz using an Alinco DJ-S11T connected to a simplex repeater module along with a secondary APRS transmitter. Near the bottom of the flight train I also included a FindMeSpot GPS tracker that sends position data up to the orbiting GlobalStar network every 10 minutes. The FindMeSpot is a neat backup GPS unit that will actually transmit its position to the satellites (and from there to a website) even while upside down on the ground. It's a handy device that can save the day if the APRS units are out of range of local digipeaters after the payload has landed following its flight into the stratosphere. Check out <http://www.findmespot.com> for more info on this 7-ounce wonder.

Thanks to Hank Cantrell, W4HTB's efforts we were able to inflate the balloon inside the Fruit of the Loom jet hangar at the Bowling Green airport. We had a large crowd of onlookers and even managed to have the kids in attendance build some ping-pong-ball experiments that are called PearlSats, a concept developed by Dr. Bob Twiggs, who came up with the idea as a neat way to send up very small student experiments on a balloon. Each kid's experiment is strung on the flight line like a string of pearls (see photo 2). In addition, Hank W4HTB, Shane Wilson, N4XWC, and I designed a 1255-MHz FM Amateur Television (ATV) transmitter to provide real-time, live camera video from the balloon during its flight.

Photo 1. Student Jessamyn Delgado buttons up the Balloon-1 payload while Dr. James Lumpp observes on the right.

Photo 2. Teacher Flo Bower helps the kids make PearlSat experiments out of ping-pong balls.

Photo 3. The launch of Balloon-1.

We managed to get everything off the ground, even after Mother Nature huffed and puffed as we brought the balloon outside of the hangar. The launch went well in the breeze with the exception of nearly taking out one of the news cameramen who got a extreme close-up of the launch before one of the payloads made a close encounter with his camera and knocked it (and him) to the ground (see photo 3).

We were fortunate that the Kentucky Emergency Management van (as well as the Kentucky National Guard van) had decided to participate in the launch as an exercise of their equipment and capabilities. We were able to set up the command station inside a spacious and air-conditioned van (very handy to have on a hot and steamy July day) that had an operating area that was a ham's dream station. Several VHF and HF radios were at our fingertips, along with a high-speed satellite internet connection to relay streaming video from our ground station. The van had a pneumatic mast antenna for its command radios that also sported a bird's-eye view of the launch site from a steerable video camera perched at the top of the mast (photo 4).

From the air-conditioned comfort of our ATV station inside the van we had snow-free reception from the FM ATV transmitter on 1255 MHz throughout

Photo 4. The ground station was located inside the Kentucky Emergency Management vehicle.

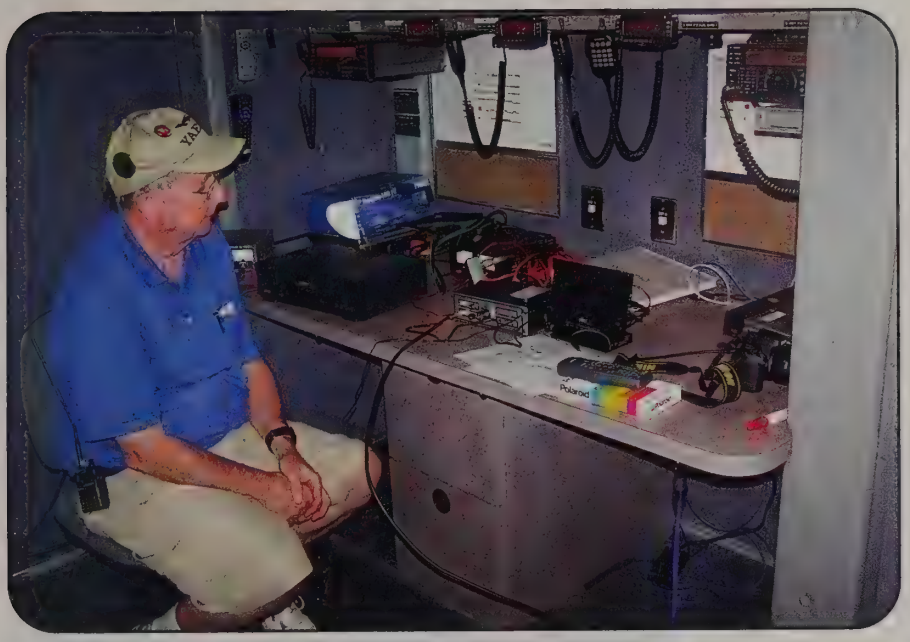

Photo 5. Hank Cantrell, W4HTB, mans the ATV and 2-meter simplex repeater ground station inside the van.

most of the flight, while operating net control for the simplex 2-meter repeater experiment (photo 5).

The 2-meter simplex repeater payload worked great and demonstrated the wide-coverage possibility of a balloon-borne repeater for emergency and disaster communications. We had numerous contacts with stations in Ohio, Indiana, Illinois, Kentucky, Tennessee, Georgia, and Alabama. Some were able to contact us from their mobile rigs from hundreds of miles away. The potential for a two-way contact between stations over 700 miles apart is possible when the balloon is at peak altitude (over 90,000 feet).

The flight reached its peak altitude about 90 minutes after launch and parachuted down about 28 miles to the southeast of Bowling Green. It turns out that the FindMeSpot unit saved the day, since both APRS trackers dropped out of digipeater range before sending back the final landing spot. Fortunately, as we were plotting the FindMeSpot landing coordinates, we got a phone call from a woman who had just found everything lying neatly in her front yard near her driveway a few minutes before the student chase team arrived (photo 6). No tree-climbing or hiking into the wilderness this time!

A fun time was had by all, and we plan to fly more payloads on the 23-cm band in the future. The next flight may carry aloft a simplex ATV repeater relay which could potentially allow ATV operators in several states the ability to contact each other through the balloon repeater.

Check out my website (www.wb8elk.com) for future flight announcements and payload details. In the coming months, I'll be trying some long-duration flights that may also have some SSTV transmissions from them as well as a variety of digital modes on HF and VHF. You can also check <www.arhab.org> to see flight announcements from other balloon groups across the country, as well as around the world. 73, Bill, WB8ELK

Photo 6. The student chase team makes a successful recovery.

By Mitch Gill, NA7US

EMERGENCY COMMUNICATIONS

The Role of VHF in EmComm

Introducing NA7US and a New Column

Hello fellow lovers of VHF. When I was asked by *CQ VHF* magazine editor, Joe Lynch, N6CL, if I would be interested in writing a column on emergency communications, I jumped at the opportunity. For those of you who do not know me I will give you a brief autobiography. OK, the truth is I will try to be brief, but I make no promises.

Personally, I think that writing a short autobiography is not half as bad as having to read it. Just think of some syrupy medicine that you hated as a child. Hold your breath and swallow it fast, because you are going to have to endure it anyway.

It is hard for me to believe that I was first licensed 40 years ago at the tender age of 14. From 1969–1973 my love of CW grew. It became a second language for me, but girls and college soon moved me in a different direction until I joined the USAF in 1976 and became a radio operator. I stayed in until 1984, having served as the Base VHF Communications Chief, European MARS Director, and NCO in charge of Emergency Communications. I also passed my General Class amateur radio test while stationed at Rhein-Main Air Base, Germany from 1978–1983.

From 1984 to 2003 I worked with various companies in high-tech and communications contracts, but 9/11 affected me as it did all of us. In addition to the patriotism we all felt, I longed to go back into the service. I thought they could use an old sergeant like me in the rear.

NA7US posing at his emergency communications setup.

The Army? Iraq? At My Age?

In 2002, I became an Amateur Extra, and in 2003 I rejoined the service at 49 years old. I joined the Washington Army National Guard, as it was the only one that said I was not too old. In 2006, instead of the rear, I went to the front lines in Iraq. While I was there I did get a chance to operate for a few months as YI9TU, but it was sporadic, as we worked 7 days a week, 12 hours a day. I did manage to make over 1000 contacts. It was odd working stations during a mortar attack, but there really was nowhere to hide from them. To tell you the truth, amateur radio helped me relax almost as much as talking to my family on the phone.

Other than a year in Iraq, I have worked for the past six years in the Joint Operations Center as the Operations NCO and Subject Matter Expert (SME) in Communications. In a future column I will give you a tour of our communications system. Prior to my being there, they had one HF radio, but now we have five. They also had no VHF stations, and now we have three, two digital modems, GPS-enabled handhelds, and more. Some officers think I am building a ham radio station rather than an emergency communications center. The truth is that I am looking forward to the 12-element 2-meter beams that will be mounted on our 80-foot tower. Since contests fall on weekends, I just might have to test and see how far we can communicate with a hundred watts. Hey, it's for the good of the service!

Don't Let Me Fool You; It's a Brag Tape

Let's get back to emergency communications before I start talking about my attempt at 2-meter EME from Iraq, which I will save for a later time. I have worked in ARES (Amateur Radio Emergency Service), held the position of Emergency Operations Officer in MARS, and was involved in emergency communications for the 52 hostages taken in 1979 in Iran, the attempts by the Russians to stop Poland from breaking away (SOLIDARITY), dozens of emergency exercises, one earthquake, one volcano eruption, two hurricanes (deployed to Louisiana during Katrina and Rita), and one war. I have known friends whose lives depended on VHF communications and those whose lives were made a little easier during a trying time.

If I sound like I am bragging, I apologize. I just happened to be in the wrong place, or right place, at the right time, and yes, I admit that I am proud to have served my country and continue to do so to this day. My most interesting times have been while I was in the service.

I have always had a passion for emergency communications. Part of my job today is to look at the worst-case scenarios and figure out how we can still communicate. At that time I decide

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what equipment to purchase, and if the colonel agrees, we buy it. I have always chosen amateur radio, as it is less expensive but has more capabilities that fit our needs. It would never survive a ride in the desert in a HUMVEE, but to get it "battle hardened" would be costly—about ten times the cost of an ICOM 756 Pro. Another part of my job is Homeland Security and Force Protection. The combination gives me a unique opportunity to see more than the average citizen, and the commanders allow me the leeway to influence how we will operate in the event of a catastrophe. It is humbling at times, as I am no smarter than any of you. Again, I just happen to be in the right place at the right time.

Some Final Thoughts

In a future column I will be showing you a state Emergency Operations Center (EOC), its communications capabilities, and its relationship with ARES. Together we will explore some of the county EOCs, as well as some small and large city EOCs with an emphasis on their VHF capabilities. As many of you are aware, VHF plays a major role in the EOCs.

Therefore, let me start with a question for you to think about. If interoperability is the key today to communicate between services such as police and fire, how can we incorporate amateur radio? I have not seen a real push in that area, although I have seen the government stating that they want to incorporate hams and MARS into its planning, but I believe there are issues surrounding our regulations. What do you think?

I am hoping that those of you who work in ARES, RACES, MARS, and those who volunteer when an emergency arises will provide me with your thoughts on emergency communications. I would also like pictures of any "fly away" kits that you have built. I need high-resolution photos if you want to see them printed; 600K or more in size will work well. Send them to me directly at <NA7US@arrl.net>.

That's all for this first issue. I look forward to hearing from you and also look forward to mutually delving into emergency communications and how VHF plays a major role. Until the next time, follow the Boy Scout motto: Be Prepared!

73, Mitch, NA7US

By Keith Pugh,* W5IU

SATELLITES

Artificially Propagating Signals Through Space

ARISS – Amateur Radio on the International Space Station

In my last column in the Winter 2009 issue of *CQ VHF*, I mentioned the 10th anniversary of ARISS (Amateur Radio on the International Space Station) and the 25th anniversary of amateur radio in human space flight. Having just completed a tour of duty as an ARISS Operations Lead, I have gained additional insight into the purpose, organization, and operations of ARISS. I would like to share this insight with all members of the amateur radio community. This column will be limited to my observations and opinions. Additional details (such as names of current personnel) are available at <http://www.ariss.org> and other sources. This column will lean heavily towards portraying the day-to-day operations of ARISS.

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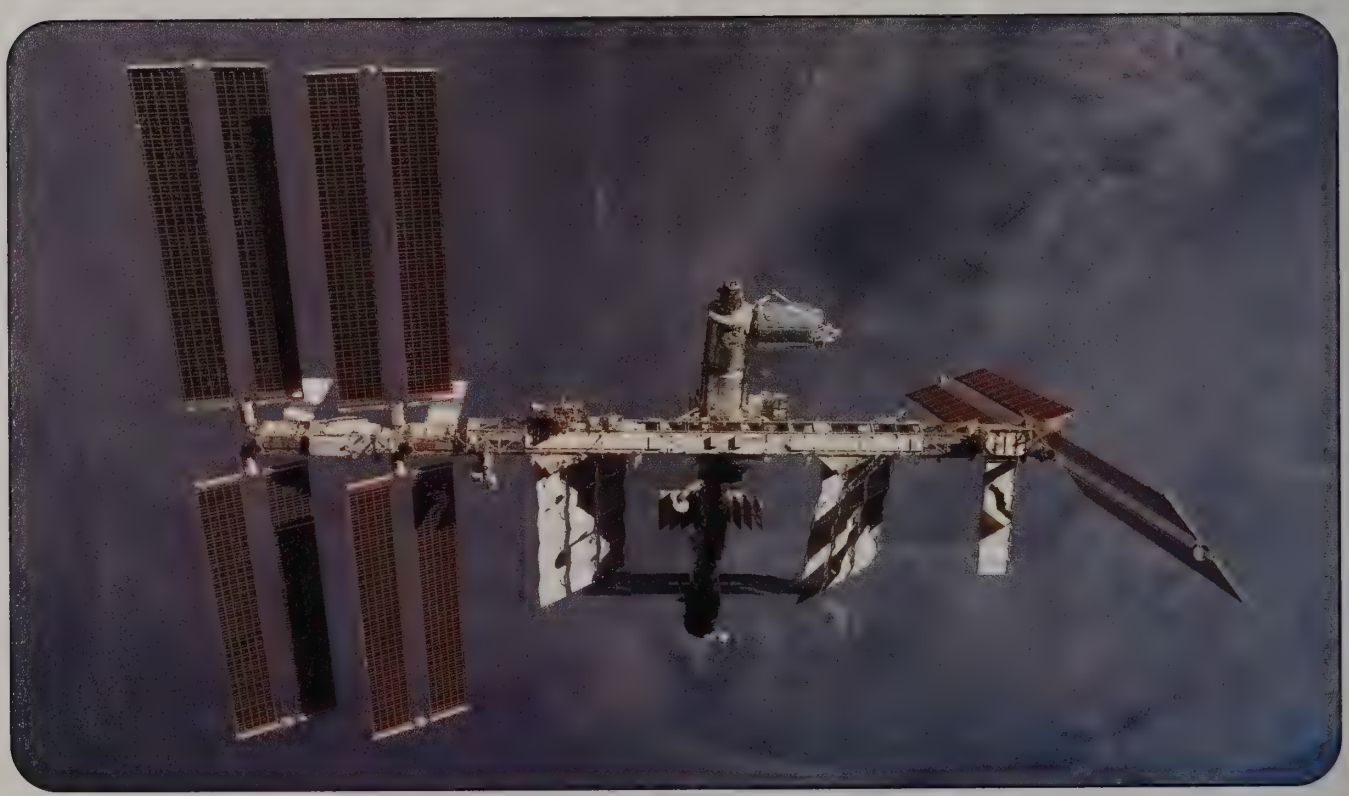
ARISS's Purpose

The primary purpose of ARISS is to promote education of our youth in math, the sciences, engineering, and technology through exposure to the International Space Station Program. A secondary purpose is to expose students and others to the world of amateur radio and the many benefits of this fascinating avocation.

Working with professional educators worldwide and with the space agencies of the world, ARISS provides opportunities for students of all ages to talk and exchange ideas with astronauts on board the ISS (International Space Station) while in orbit. Amateur radio provides the medium for this exchange to occur and the volunteers who facilitate the primary purpose.

ARISS Organization

Based on a proud legacy of human space flight dating back to 1983 and Owen Garriott's STS-9 flight, including SAREX (the Shuttle Amateur Radio Experiment) and MIR, ARISS was formed in 1996. the founders were Roy Neal (SK), K6DUE; Frank Bauer, KA3HDO; Rosalie White, K1STO; and Matt Bordelon, KC5BTL. The team is governed by a group of ARISS International Working Group delegates from Canada, Europe, Japan, Russia, and the United States. Delegates are chosen



Backdropped by a cloud-covered part of Earth, the International Space Station is seen from Space Shuttle Atlantis as the two spacecraft begin their relative separation. Earlier, the STS-122 and Expedition 16 crews concluded almost nine days of cooperative work on-board the shuttle and station. Undocking of the two spacecraft occurred at 3:24 AM (CST) on February 18, 2008. (NASA photo)

from the AMSATs (Amateur Radio Satellite Corporation) of the world, the national amateur radio organizations (such as the ARRL), and the space agencies of the world. These delegates meet via monthly telephone conferences and about once a year at face-to-face meetings (last year's was in Moscow, this year's in the Netherlands). In between, activities are coordinated by e-mail and additional telephone conferences as necessary. These delegates set the policy (with advice from the space agencies) for operation, coordinate equipment for the ISS, coordinate with education organizations, coordinate school selection for contacts, and provide oversight to the ARISS Operations Team, the other major ARISS group.

The ARISS Operations Team is made up of ARISS mentors, scheduling/technical representatives, and an orbital prediction specialist. An ARISS Operations Lead is selected from within the ranks on a periodic basis. This group meets weekly by telephone conference and much more frequently via e-mail and individual telephone conversations. ARISS mentors are the volunteers who work with the schools, teachers, and local amateur radio groups that actually make the contacts with the ISS. Scheduling/technical representatives work within the space agencies, primarily NASA in the USA and the Russian Space Agency, to secure the final schedules for the contacts. These scheduling representatives also coordinate training of the astronauts in the use of the equipment on-board the ISS and procedures for its use. The orbital prediction specialist does the long- and short-term predictions necessary to support the scheduling of all of the contacts. I will talk more about these functions and their relationships to each other in subsequent paragraphs outlining the scheduling and performance of the contacts.

ARISS Operations

The wheels start rolling with the submission of an ARISS application for an ISS contact. Ideally, a teacher hears about the possibility of a contact through professional societies, from other teachers, from amateur radio operators within the community, or by many other routes. The teacher, with the help of local amateur radio operators, fills out the multiple-part application and submits it to the regional ARISS organization. The regional organization reviews the application, obtains clarification if necessary, ensures the application is forwarded to the ARISS international education committee, and enters it into the list of applications in the order in which it was received. A separate list is maintained for each region of the world, and candidates are picked from each region in proportion to the number of applicants on the list. Another list is maintained for "Crew Pick" contacts. These contacts are with schools that are picked by the astronauts for their own reasons and are usually separate from the main list. Astronauts are allocated "Crew Pick" contacts based on their interest in the program and willingness to support contacts from the main list.

The main list can be quite long and the waiting period can be correspondingly lengthy. Currently, the wait for U.S. applicants is about one year. Every effort is made to keep the wait to a minimum, but contacts generally are limited to somewhere between one and four a week, depending upon the crew's willingness to support contacts and the workload on the ISS.

Another factor to consider is whether the contact is to be "direct" or via "telebridge." For a "direct" contact, a ground station is set up at the school and the contact proceeds directly through that station with the station on-board the ISS. For a "telebridge" contact, the ground station is located remotely

(possibly half way around the world) from the school and the ground station is connected to the school and other elements through a telephone conference bridge. ARISS Operations has developed and maintains a list of acceptable telebridge stations around the world (these are currently in the mainland U.S., Hawaii, Australia, Argentina, Belgium, and South Africa).

The school expresses a preference for the type of contact in its application and ARISS Operations will honor this preference whenever possible. A telebridge contact requires much less equipment at the school and is much more flexible on timing of the contact than a direct contact; however, it actually requires more coordination on the part of ARISS Operations to carry it out. A list of requirements for each contact follows:

1. The ground station must be within the footprint of the ISS during the time of the contact and the ISS should have a peak elevation at the ground station of more than about 15 degrees. Higher passes are more desirable to maximize the contact time and minimize effects of local obstructions on the contact.

2. The pass selected must occur during normal school hours as stated on the application or within an acceptable alternate time.

3. The pass time selected must be within the crew's normal off-duty but awake time. Exceptions must be approved by the Space Agency medical personnel. Crew sleep periods normally are fixed, but can be "sleep shifted" during special work periods that coincide with Space Shuttle or other activities.

Picking and approving passes that satisfy the above requirements involve several steps that are outlined below:

1. A list of possible contacts is selected from the prioritized list of contacts maintained by ARISS over a period of time (usually for an ISS expedition).

2. ARISS mentors are assigned to each school as soon as possible. The ARISS mentor establishes contact with the school and local ham volunteers, and verifies the content of the application. (Often things change at a school after the original application was prepared.)

3. The list of candidates is broken up into direct vs. telebridge contacts.

4. Direct candidates are submitted to the orbital prediction specialist for processing into the "best weeks" list. Best weeks are long-term predictions that will permit selection of schools that have passes within a certain time frame that satisfy all of the nominal contact requirements above. A school may have several different "best weeks" within the overall time frame.

5. Selections are made based on contact priority and best weeks for each school, and the ARISS mentors obtain preferences for the available weeks from each school.

6. The ARISS mentor continues the dialog with the school to firm up the requirements for the station, answer questions from the teacher and the local amateur radio operators, assist the teacher with resources for lesson plans, solicit names of the students and questions, and obtain a short description of the school and its activities for forwarding to the astronauts. The ARISS mentor also prepares the school for filling out a post-contact survey for ARISS and NASA.

7. About four or five weeks before the week selected for a school, detailed pass predictions for the contact are requested from the orbital prediction specialist. These predictions are verified by the ARISS Operations Lead and sent to the ARISS mentor for forwarding to the school for prioritization within its

CQ's 6 Meter and Satellite WAZ Awards

(As of March 1, 2009)

By Floyd Gerald,* N5FG, CQ WAZ Award Manager

Satellite Worked All Zones

No.	Callsign	Issue date	Zones Needed to have all 40 confirmed
1	KL7GRF	8 Mar. 93	None
2	VE6LQ	31 Mar. 93	None
3	KD6PY	1 June 93	None
4	OH5LK	23 June 93	None
5	AA6PJ	21 July 93	None
6	K7HDK	9 Sept. 93	None
7	W1NU	13 Oct. 93	None
8	DC8TS	29 Oct. 93	None
9	DG2SBW	12 Jan. 94	None
10	N4SU	20 Jan. 94	None
11	PAØAND	17 Feb. 94	None
12	VE3NPC	16 Mar. 94	None
13	WB4MLE	31 Mar. 94	None
14	OE3JIS	28 Feb. 95	None
15	JA1BLC	10 Apr. 97	None
16	F5ETM	30 Oct. 97	None
17	KE4SCY	15 Apr. 01	10,18,19,22,23, 24,26,27,28, 29,34,35,37,39
18	N6KK	15 Dec. 02	None
19	DL2AYK	7 May 03	2,10,19,29,34
20	N1HOQ	31 Jan. 04	10,13,18,19,23, 24,26,27,28,29, 33,34,36,37,39
21	AA6NP	12 Feb. 04	None
22	9V1XE	14 Aug. 04	2,5,7,8,9,10,12,13, 23,34,35,36,37,40
23	VR2XMT	01 May 06	2,5,8,9,10,11,12,13,23,34,40
24	XE1MEX	19 Mar. 09	2,17,18,19,21,22,23,26,34,37,40

CQ offers the Satellite Work All Zones award for stations who confirm a minimum of 25 zones worked via amateur radio satellite. In 2001 we "lowered the bar" from the original 40 zone requirement to encourage participation in this very difficult award. A Satellite WAZ certificate will indicate the number of zones that are confirmed when the applicant first applies for the award.

Endorsement stickers are not offered for this award. However, an embossed, gold seal will be issued to you when you finally confirm that last zone.

Rules and applications for the WAZ program may be obtained by sending a large SAE with two units of postage or an address label and $1.00 to the WAZ Award Manager: Floyd Gerald, N5FG, 17 Green Hollow Rd., Wiggins, MS 39577. The processing fee for all CQ awards is $6.00 for subscribers (please include your most recent *CQ* or *CQ VHF* mailing label or a copy) and $12.00 for nonsubscribers. Please make all checks payable to Floyd Gerald. Applicants sending QSL cards to a CQ Checkpoint or the Award Manager must include return postage. N5FG may also be reached via e-mail: <n5fg@cq-amateur-radio.com>.

**17 Green Hollow Rd., Wiggins, MS 39577; e-mail: <n5fg@cq-amateur-radio.com>*

own school schedule. The passes are ranked #1 through #n by the school and the local amateur radio operators and sent back to ARISS Operations.

8. At this point, the pass ranking, student names, questions, and school description are passed on to the NASA planners by the ARISS scheduling representative for final determination of the selected pass. Usually this final pass time is available one to two weeks before the contact. In the case of Russian contacts, a similar process is performed with the Russian Space Agency.

9. Before the contact time, a final uplink message is sent to the astronaut containing the time, station callsigns, frequency information, school description, and students' questions (along with the students' first names) in the order the questions are expected to be asked.

10. At this point, the contact is ready to go from a planning standpoint.

For telebridge contacts this process is modified somewhat. Telebridge contacts are usually fit into the schedule between the "best weeks" for direct contacts, or are scheduled during special times that are specified by the school or event and agreed to by ARISS Operations. Telebridge contacts are usually reserved for schools that either cannot obtain local ham club support for a direct contact or have time requirements that are not flexible. The modified steps for a telebridge contact follow:

1. Telebridge contacts are prioritized by the same process as direct contacts, but they are usually done when direct contacts are not possible.

2. For telebridge contacts, the orbital prediction specialist prepares a list of the passes for each telebridge station that can support a contact during the dates/time frames requested by the school and within crew constraints. This list can contain many passes and multiple stations.

3. The ARISS Lead pares down the list when possible and sends the remaining passes to all of the telebridge stations that have passes on the list for verification of support.

4. The ARISS Lead receives the responses from the telebridge stations and prepares a list of available passes for further prioritization by the school. This list is sent to the ARISS mentor and he/she forwards this list to the school.

5. Once the prioritized list is returned by the school, the process continues in much the same manner as for a direct contact.

6. One other step is added: a contact moderator is selected by the ARISS Lead to oversee final readiness verification at the school and at the telebridge station. The moderator also makes sure school personnel and any audience are aware of how the contact will be done and the amateur radio involvement in the contact. A moderator is added, since many times the level of expertise at the school during the contact is less than it would be during a direct contact.

7. At the appropriate time, the moderator turns over control to the telebridge station to establish contact with the ISS.

8. Control is then maintained by the telebridge station operator and the school contact supervisor until the pass is over.

9. The moderator then completes the process with a closing statement.

In recent years, ARISS has succeeded in including distribution of the audio from the contact over the internet by utilizing EchoLink and IRLP. These are two methods of including many more listeners worldwide in the distribution. Doing this with a telebridge contact is relatively easy. With a direct contact it is a little more difficult, but recently success has been achieved by feeding the audio into a PC at the school and utilizing Skype (an internet telephone) to forward the resulting information to the operator who completes the conversion to EchoLink or IRLP. These operations are also carried out by ARISS volunteers.

The last thing that happens in an ARISS contact is the enthusiastic response of the school kids, and their increased interest in science and ham radio when the contact is successfully completed. This is the "pay" the volunteers cherish for their efforts and is the reason we eagerly volunteer for this duty.

Summary

I hope this column has given you some additional insight into ARISS and the process of scheduling and conducting ARISS contacts. I also hope no one is scared away by all of the details involved. After all, ARISS is always looking for a few more good volunteers and a few more enthusiastic school teachers to "share the wealth."

Since the ISS was launched, over 400 of these school contacts have been conducted and over 40 have taken place on Expedition 18 during the last six months. Many more are planned in the future. The 400 number does not include all of the SAREX and MIR contacts that preceded ISS operations.

Don't forget to support ARISS in its education efforts. Also, please support AMSAT in its fund-raising efforts so that they can continue to put more "birds" on the air. 'Til next time . . .

73, Keith, W5IU

By Miguel Enriquez, KD7RPP

ATV

Amateur Television for Fun and Education

ATV, ARRL's Teacher Institute, and Ham Radio in Public School Curriculum

A philosopher once wrote, "Against our will comes wisdom." At first glance one might ask what this statement might have to do with amateur radio and ATV. Well, recent circumstances and activities surrounding the Pueblo Amateur Radio Club have everything to do with the statement.

For the last two years, the Pueblo Amateur Radio Club has been busy exploring many different facets of radio. Some of our students are working on underwater robots controlled via RF. Others are busy building antennas and testing them. Still others have been working on basic electronics and math classes to be taught via ATV for the benefit of elementary school children in southern Arizona and in London, England. In addition, our radio club has now begun taking images of celestial bodies such as planets, nebulas, and galaxies through remote-imaging telescopes in New Mexico and Pengally, Western Australia. All of these activities are in pursuit of bettering knowledge, understanding, and test scores in mathematics and science.

It would be nice to be able to report that as the students demonstrate improved test scores and general enthusiasm for the projects in which they are involved, the resources necessary to accomplish the goals that will add to their education would become more available. However, because of the economic climate we all face, and especially in Arizona where state funding for education is now 50th in the nation, available resources are drying up quickly. It would be natural to expect the students to give up or slow down their enthusiasm for the projects they are working on. However, just the opposite is taking place.

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Tiernan Walker, a fourth-grade student from Jefferson Park Elementary school, poses in front of a chromo green screen with satellite antenna and HT to demonstrate correct emergency communication procedures. Pictures are to be used for development of ATV video vignettes.

Our radio club motto is "Touch the Sky." Our students have concluded that touching the sky can happen as long as one absolute requirement is present—imagination. Therefore, instead of the students complaining about the radio club not having the $300 for the application fees to the underwater tournament this year, they will continue working on the robot and make it a better one for next year's competition. Instead of griping that the radio license fees are not there for the students to take their Technician amateur radio test, they will just keep moving along and take the test when they finish studying for their General exam, hoping the fees will be available someday.

Something else very positive has come out of these trying times. Last year Pueblo Magnet High School was one of six sites that hosted an ARRL's Teacher Institute. The ARRL Teacher Institute (TI) is a program presented by the ARRL for teachers with the objective of assisting, enhancing, and improving science and mathematics comprehension for American students. The program is run exclusively through philanthropic support, and thanks to the magnificent contributions of Mark Spencer, WA8SME, the program is an overwhelming success every time it is presented.

This year, because general economic conditions are difficult and resources are becoming more limited, and because many of the Pueblo faculty are witnessing the obvious successes my math and radio club students are demonstrating, the 2009 ARRL TI at Pueblo High School will be filled exclusively with math, science,

Tiernan uses the ARRL Teacher Institute Banner to communicate the ARRL educational services to teachers via ATV.

career and technology, and special education teachers from Pueblo High School. The teachers will attend the TI June 15 –18. Plans are already under way to "pool" the resources that the ARRL provides to individual teachers and to create a "class set" of materials and equipment that can then be shared by the different departments and classrooms to provide exciting "hands-on" opportunities for students to add more relevance to their daily lessons.

Students will be able to use tools provided by the ARRL to receive and process images from weather satellites to add to their study of earth science. Learning scientific notation takes on a whole different meaning when students are able to employ Ohm's law to predict the reading on the multi-meter readout panel as they vary resistance in a circuit. A greater number of students will be able to apply their learning in a laboratory setting while having fun experimenting with math and science.

Another exciting development at Pueblo Magnet High School is that a new radio/video course has been added to the Pueblo curriculum to teach radio, space, and wireless technologies. The course must meet Arizona State Standards that will employ amateur radio, robotics, radio astronomy, and amateur television as course content. The students will prepare for their FCC amateur radio licenses as part of the class curriculum. The students will be required to meet a minimum of 80% of the Class State Standards and pass qualifying exams. The program is being funded through the Pima County Joint Technological Education Program and should provide resources for equipment and materials. Furthermore, I am currently taking the course work to add Career and Technology Education to my teaching certification.

Several of the Pueblo faculty members who will attend the Teacher Institute have expressed an interest in obtaining an amateur radio license. If this were to happen, only bigger and better opportunities await the Pueblo Amateur Radio Club.

In addition, ATV will be at the Pueblo Magnet High School 2009 ARRL Teacher Institute to record these auspicious events, and if we ever do get enough bandwidth to the internet connectivity at Pueblo, we will provide those videos through the Arizona Amateur Television Network.

If you are a teacher or know teachers somewhere, suggest they look into attending the ARRL Teacher Institute. It is designed primarily for teachers who are not ham radio operators.

Therefore, returning to Aeschylus' quotation at the beginning of this column, if it were not that present economic and political situations locally provide never-before-seen challenges, the Pueblo Amateur Radio Club and ATV would not have the magnificent opportunities before us. If the new radio/video class is to be the success I envision, a tested and successful amateur radio/video curriculum would be made available to other teachers around the country for their use.

Hope is a good thing. 73, Miquel, KD7RPP

By Kent Britain,* WA5VJB

ANTENNAS

Connecting the Radio to the Sky

Stacking Broadband Antennas

One common question from our readers is how to stack log periodic or other broadband antennas. The wide variation of wavelengths used in antennas such as the ones in photo 1 creates a multitude of problems, not the least of which is evenly dividing power between the two antennas. However, there are several ways to divide the RF power between two antennas even over a broad range of frequencies.

Quarter Wave: In photo 2 we have the classic 1/4-wave power divider, two sections of coax 1/4-wave long and 72-ohm impedance. While this is the usual way of stacking two antennas, the power divider has a bandwidth of about ±10 percent. This means a power divider for 2 meters works fairly well as a power divider from 130 MHz to 160 MHz. This is fine for 2 meters, but it is not going to hack it for multiband antennas.

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Multi-Stage Quarter Wave: Sometimes known as a "multi-section inline hybrid," a series of stepped quarter-wave sections with different load resistors can give a pretty good bandwidth of 2 to 1 or more depending on the number of stages. Specifications of 1 to 2 GHz, or even 2 to 8 GHz, are often seen on surplus power dividers. This is good for microwave use but kind of big for VHF antennas. In photo 3 you can see the small chip resistors at the junctions. I sacrificed another power divider on the altar of knowledge so I could cut it up and measured the 100-, 220-, and 450-ohm resistor values.

Ferrite: These simple two-way splitters designed for use with televisions (photo 4) are very handy little splitters or combiners. First, they are *not 75 ohms!* Rather, they are transformers and are quite happy with all three ports at 30 ohms, 50 ohms, or even 100 ohms. Again, they are transformers and just need all three connections at the same impedance. With adapters on the F-connectors, or taking out the transformer and putting it in your own box will make a handy splitter/combiner with 50-ohm coax systems.

Yes, some electronics stores sell them for $10 or more, but the ones at the dollar stores for $1 work just as well! Furthermore, you can take them apart and put the ferrite transformer directly into your projects. The first time I tried this, I exclaimed, "Boy, look at those long leads. I can made it work much better by using shorter leads!"

That turned out to be another one of those brilliant ideas that didn't work out very well. The inductance in the long leads is part of the device impedance matching, and you really need to keep the leads the same length as much as possible.

The frequency range depends on the type of ferrite used, its size, and the number of turns. TV splitters work pretty well from 50 MHz to 1000 MHz. A quick scan of the MiniCircuits catalog shows other variations for use from 50 kHz to 2 GHz. Again, the ferrite splitter/transformers

Photo 1. Wide-bandwidth antennas.

are good when the antennas are used to receive, but the ferrite saturates at about 1 watt, so is not so good for transmitting.

Tapered or Infinity Balun: If you change impedances quickly—that is, go from 50 ohms to 100 ohms—the impedance change causes the wave to reflect. In the case of a 50- to 100-ohm change or impedance bump, you would see a 2 to 1 SWR. However, let's say we didn't have a sudden change, but rather just a slow change from 50 to 100 ohms. There wouldn't be a sudden impedance bump and there would be no change in the SWR. This is the idea behind the tapered balun—just a slow change in impedance over a modest distance. Shown in photo 5 are the top and bottom sides of a tapered balun I am using with an Archimedean Spiral array that goes from 50-ohm to

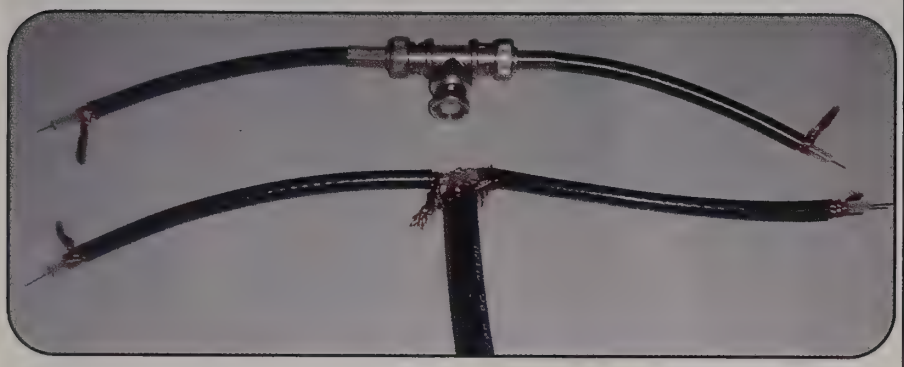

Photo 2. Quarter-wave antenna phasing lines.

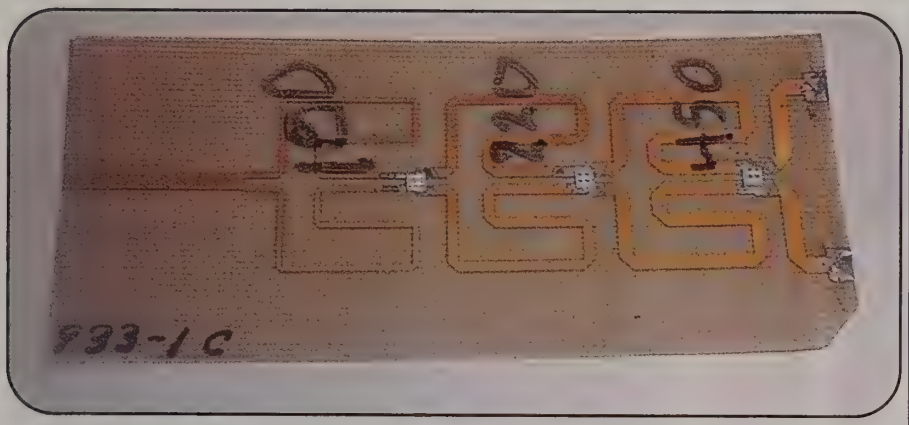

Photo 3. Multi-stage quarter-wave Wilkinson power dividers.

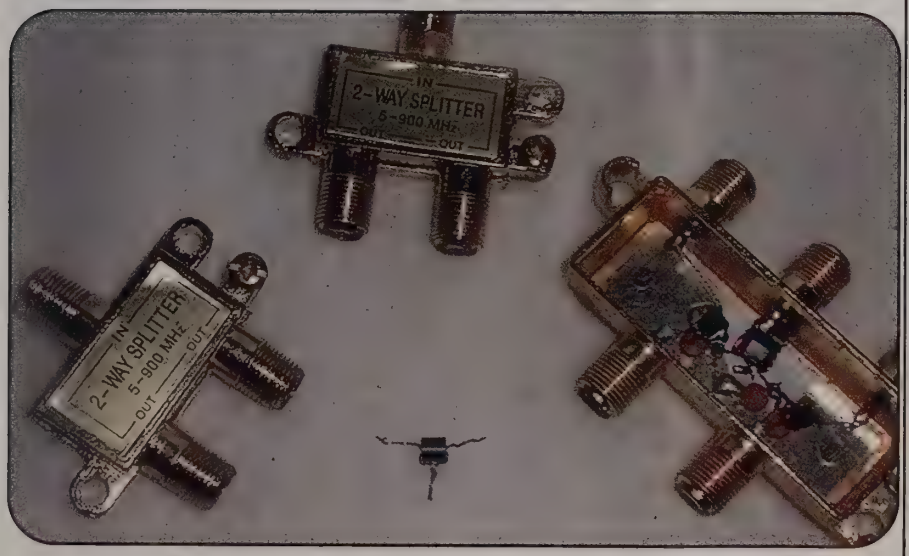

Photo 4. Ferrite power divider/combiner.

110-ohm balanced line, or 110-ohm twin lead. The taper needs to be at least 1/2-wave long, and longer if you have room.

In photo 6 is a tapered power divider for a UWB, or ultra-wideband antenna array. Note how the lines are narrow at the junction and fatten up at the antennas. The lines are 72-ohm impedance at the junction, widening to 50 ohms for the individual antennas. For UWB, the normal 1/4-wave matching lines were just not going to work. There is too much frequency spread, especially for the pulse UWB modulations. As soon as I get my technique down, I'll show you how you can make one of these tapered power dividers out of semi-rigid coax or small hardline.

T-Connector: Perhaps the lowest loss power divider is just a T-connector like the ones in photo 7. Redesigning an antenna such as a log periodic for 100-ohm impedance is quite easy, as log periodics naturally like to be just over 100 ohms. Use two feedlines the same length and the two 100-ohm antennas parallel to 50 ohms. This is the lowest loss way and widest bandwidth way to combine antennas, but redesigning the antennas

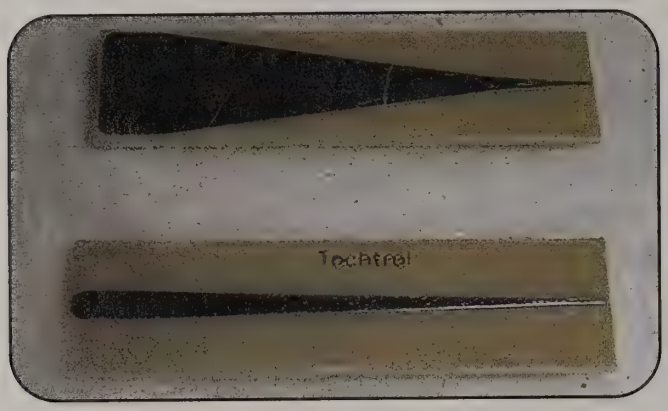

Photo 5. Tapered impedance-matching lines.

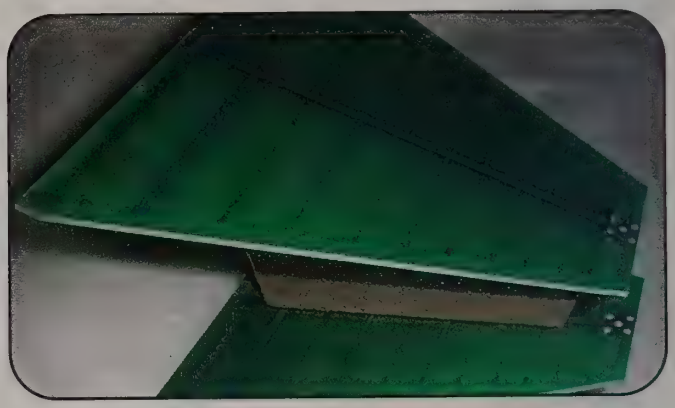

Photo 8. Stacking.

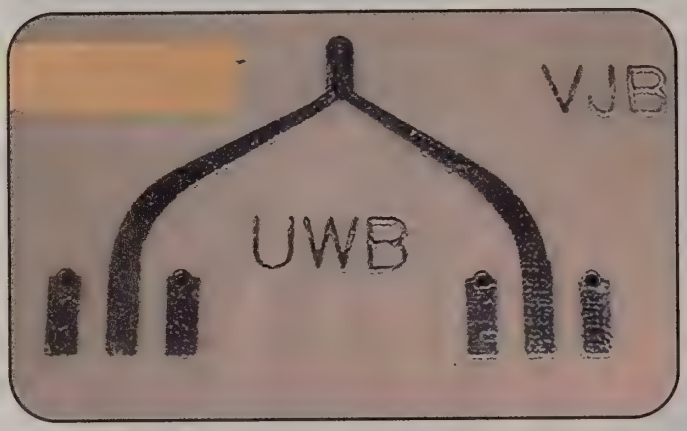

Photo 6. Tapered power divider.

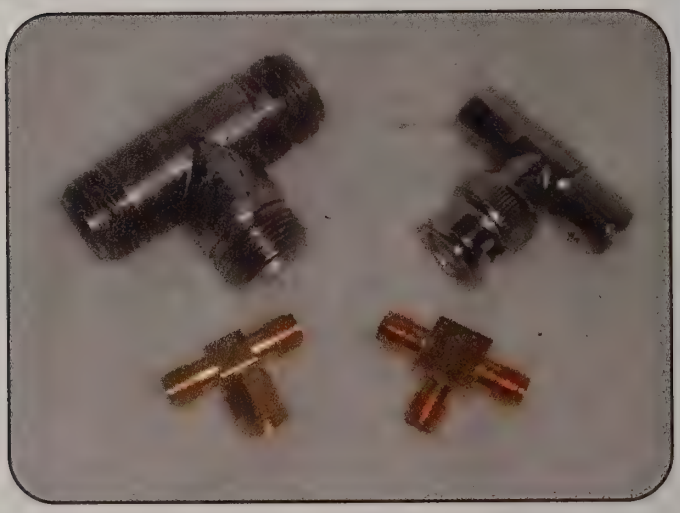

Photo 7. T-connectors.

Photo 9. Big beacon antennas.

Photo 10. Jim, KI6WJ's homebrew AO51 antennas. (KI6WJ photo)

is not always easier. Often designing the radio stages to 25 ohms is easier.

Resistors: A pair of 50-ohm resistors makes an excellent broadband power divider, but you do have the tiny detail that you will lose half of the power in those resistors. There may be an advantage in that you have a narrower antenna pattern, but this is a rarely used technique and for good reason.

Spacing: When stacking Yagis or dipoles, you have a preferred stacking distance. For Yagis the best stacking distance is about 1/2 the length of the booms. For dipoles it's usually about 1/2 wavelength. To maintain the proper stacking distance with antennas such as log periodics, you end up with something like the spacing in photo 8. It looks kind of strange at first, but the low-frequency elements and the high-frequency elements of the log periodic are the same distance apart in wavelengths.

Big Beacons Anyone?

It looks like we will have an opportunity for some fantastic beacon antennas in the Dallas, Texas area, and something you might look into in your area. After June 12, 2009, about 5000 analog TV stations will go dark. That means about 5000 fantastic beacon antennas will be unused, including the one in photo 9. Like all fantastic deals, there are a few points in the fine print. It varies from location to location, but most TV stations pay about $10,000 a month in tower rent, so they will be highly motivated to get those antennas off the towers! However, at the same time there are not enough tower crews to go around, and it will be many months before they all come down. It's during this window that we have been invited by the director of engineering for one network to use its Dallas antenna. We can have some fantastic propagation beacons. Here are some quick notes on using TV antennas with ham rigs:

1. Most VHF low and VHF high/low antennas will work on any ham band. Yes, a TV Channel 3 antenna will have the gain and pattern of a bent coat hanger on 2 meters, but it's a bent coat hanger at over 1,000 ft!

2. UHF slot arrays can only be used on 902 MHz and up. The antenna slots and waveguide feedlines will not pass signals below the channel assignment—well, a few MHz perhaps, but not down to 432 MHz or lower.

3. Isolate your transmitter. It's not unusual for a TV antenna to collects *watts* of power from other nearby TV and FM stations. This power can mix in the final of your transmitter, creating high-power spurs or mixing products all over the spectrum. Your transmitter may be very clean on the bench, but with being bombarded by all those strong signals, you can really trash an area. Yes, a 50-watt transistor can function as an active mixer! Isolate your beacon transmitter with a passband filter, or better yet a ferrite isolator. If you know the frequency of a high-power transmitter just a few feet away, an additional notch filter is a good idea.

Letters, Letters . . . We Get Letters

The Cheap Yagi HDTV antenna has produced a tremendous number of e-mails. Yes, a higher gain UHF and a version incorporating VHF high elements are in the works. I hope to have these working before June 12th.

From KI6WJ: Jim sent us photo 10 of his homebrew AMSAT AO51 antennas. He calls them his "WA5VJB Pairs." It looks like the 5-element Cheap Yagis for 145 MHz and the 11-element Cheap Yagis for 435 MHz.

As always, we enjoy your input and suggestions for future topics. You can snail mail or e-mail your antenna questions and suggestions to my addresses on the first page of this column, and visit <http://www.wa5vjb.com> for additional antenna projects. 73, Kent, WA5VJB

By Tomas Hood,* NW7US

VHF PROPAGATION

The Science of Predicting VHF-and-Above Radio Conditions

More New Space Weather Discoveries

In the Winter 2009 issue we began to explore some of the new scientific discoveries and efforts being made in space weather and radio propagation during solar Cycle 23's approximately eleven years. Many new satellites and other research space craft have been launched and exciting research conducted that is leading to a deeper, better understanding of our Earth, the Sun, and the interaction between them. We looked specifically at one of the amazing discoveries made by the THEMIS (Time History of Events and Macroscale Interactions during Substorms) mission. This time, let's continue to look at more of the new science being pursued by solar scientists.

The THEMIS Mission

THEMIS is a mission to investigate what causes auroras in the Earth's atmosphere to dramatically change from slowly shimmering waves of light to wildly shifting streaks of color. Discovering what causes auroras to change will provide scientists with important details about how the planet's magnetosphere works and the important Sun-Earth connection. During February 2007, NASA launched the five space craft that make up the THEMIS fleet. The University of California, Berkeley's Space Sciences Laboratory managed the project development and is currently operating the THEMIS mission. Swales Aerospace, of Beltsville, Maryland, built the THEMIS satellites.

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Geomagnetic Substorms

Substorms are atmospheric events visible in the Northern Hemisphere as a sudden brightening of the Northern Lights, or aurora borealis. These substorms are more accurately termed "geomagnetic substorms," a description of the time-dependent build-up and release of magnetic energy in Earth's magnetosphere.

We know that space is not a vacuum, at least in our solar system. The Sun's atmosphere actually extends very far out from the Sun. Space in our system is filled with plasma, a low-density gas in which the individual atoms are charged. The temperature of the Sun's atmosphere is so high that the Sun's gravity cannot hold on to it. The plasma streams off the Sun in all directions at speeds of about 400 kilometers per second (about 1-million miles per hour). This is known as the "solar wind."

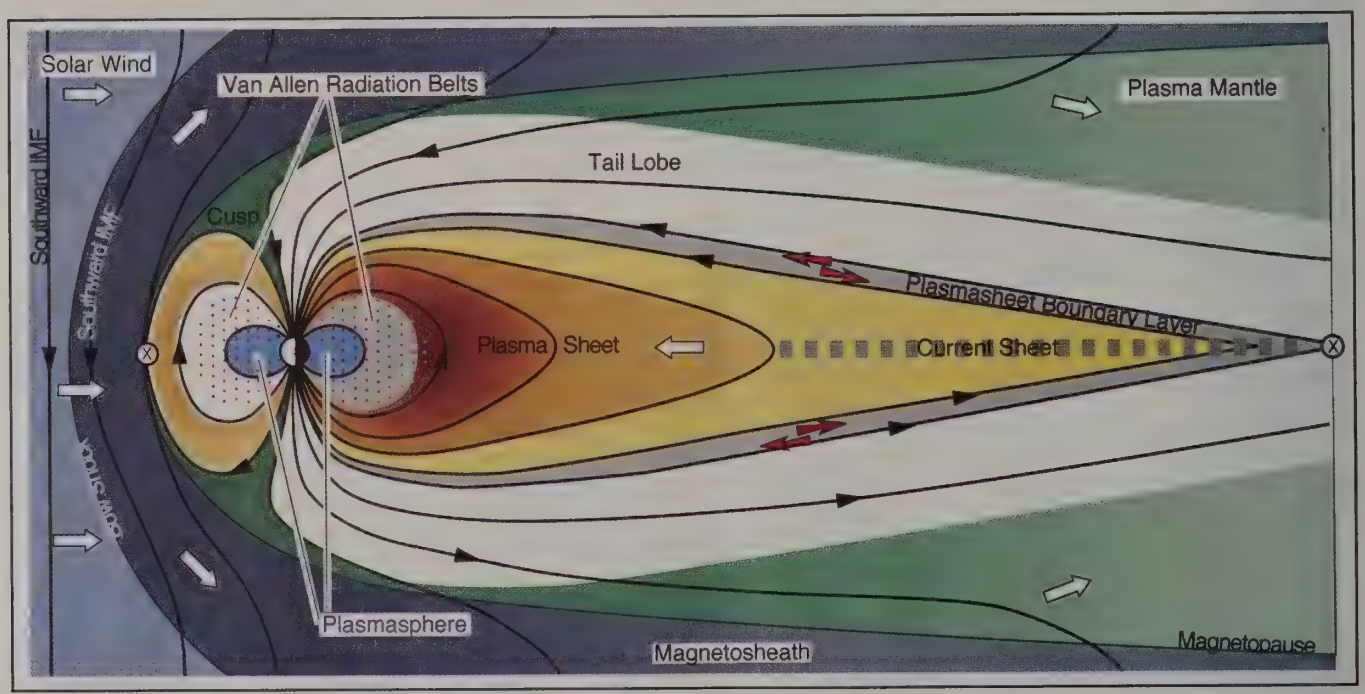

Figure 1. Schematic of the Earth's magnetosphere. The direction to the Sun is to the left. The IMF (interplanetary magnetic field), imbedded in the solar wind, impinges upon the magnetopause. If southward, as here, it connects to the Earth's magnetic field at the X-line (shown as circle with X inside), resulting in a region of field lines connecting from the Earth to deep space. Plasma from the solar wind enters via the cusp, becomes trapped in the plasma sheets, and eventually precipitates to Earth or is lost down the magnetotail. (Source: NASA)

The solar wind buffets the Earth's magnetic field and can produce storms, or more properly substorms, in the Earth's magnetosphere. Until this explosion was witnessed first-hand by THEMIS, however, scientists did not understand the full mechanisms of how substorms occurred.

The Earth has a magnetic field with a north and a south pole that is enclosed within a region surrounding the Earth called the "magnetosphere." As the Earth rotates, its hot core generates strong electric currents that produce these magnetic fields, which reach 36,000 miles into space. The solar wind distorts the shape of the magnetosphere by compressing it at the front and causing a long tail to form on the side away from the Sun. This tail is called the magnetotail (figure 1), and on average is a million kilometers long.

The ionosphere is affected by these solar-induced changes, either by an increase of ionization, or a decrease or even a depletion of ionization. Depressions in ionospheric density cause major communications problems, because radio frequencies that previously had been refracting off the ionosphere now punch through. The MUF (maximum usable frequency) on a given radio signal path can be decreased by a factor of two during a substorm event. Storm effects are more pronounced at high latitudes.

When these substorms occur, they are often accompanied by auroral "eruptions." The aurora is a dynamic and visual phenomenon caused by solar-induced geomagnetic storms (figure 2). When the solar wind interacts with the magnetosphere, under certain conditions the solar wind energizes the electrons and ions in the magnetosphere, causing solar plasma particles to enter the Earth's upper atmosphere. These particles ride down the Earth's magnetic field lines which arch toward the north and south magnetic poles. When these particles strike the molecules and atoms of the thin, high atmosphere, photons are released, creating a light show consisting of different colors.

To understand why, take a look at a neon light. When a neon light is energized, you are looking at an interaction of electrons with the gases inside the tube, resulting in plasma. Plasma conducts electricity and is also steered by magnetic fields. The color of the neon light depends on the gas that fills the tube. On a much larger scale, the solar plasma riding the solar wind is shaped by the magnetic field lines found in the magnetosphere, and produces colors depending on the gases found at the various altitudes through which the plasma passes.

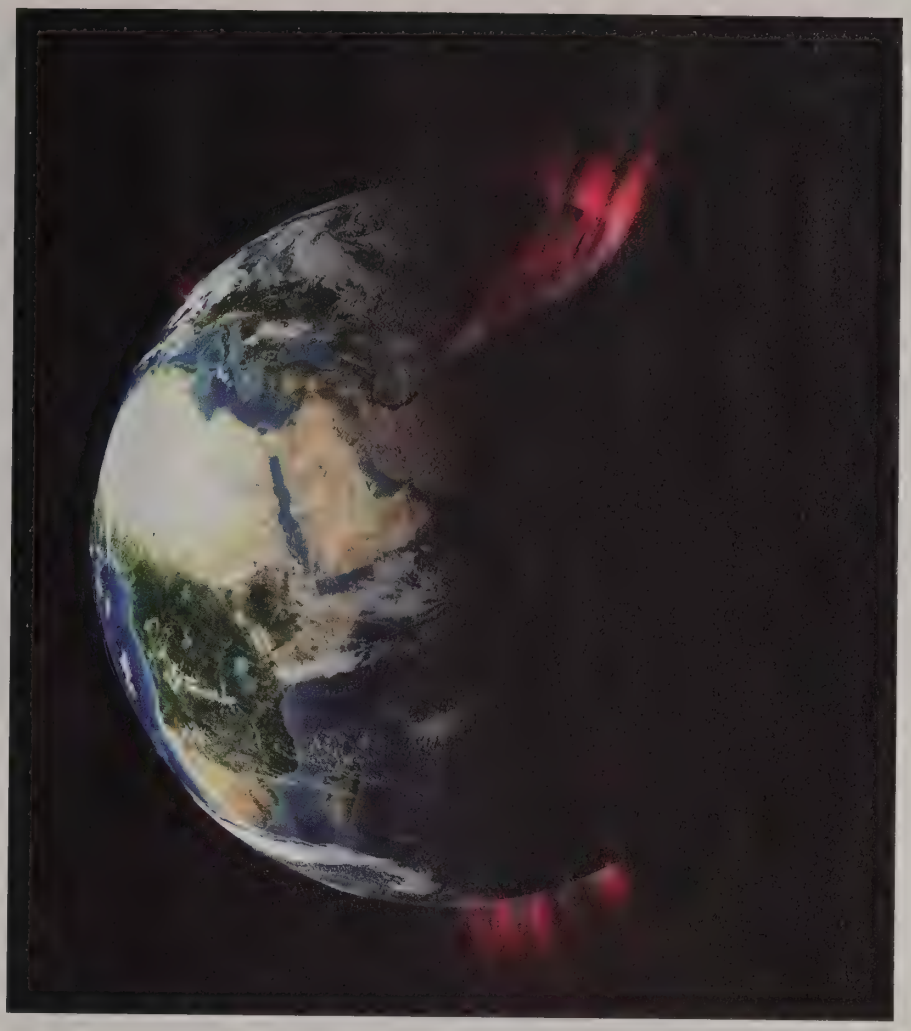

Figure 2. Artist's rendition of a substorm. (Source: NASA)

Substorms produce dynamic changes in these auroral displays seen near Earth's northern and southern magnetic poles, causing a burst of light and movement in the Northern and Southern Lights. These changes transform auroral displays into auroral eruptions. Aurora normally occurs between 60 and 80 degrees latitude, but during intense substorms, the auroral oval spreads toward the equator. During the most intense substorms, aurora has been observed all the way down to the equator, and the light show is intense with rapidly changing curtains, arcs, and other manifestations.

Substorms generally have three phases. The first is the growth phase, followed by the expansion phase, then finally the recovery phase. Because the substorm process involves the entire solar-terrestrial system (which includes the solar wind and interplanetary magnetic fields, the magnetosphere and geomagnetic field, the atmosphere and ionosphere, and so forth), intense research, such as THEMIS, is being conducted on these storms. As more facts come to light, the models used to explain this complex system are refined and tested against real data.

Plasma Bullets

During 2008 the five THEMIS satellites revealed an amazing phenomenon. While the arctic skies were dark and Earth's magnetic field was quiet with very little activity, the five THEMIS satellites had just arranged themselves in a line down the middle of Earth's magnetotail (figure 3).

Suddenly, an explosion occurred that released about 1015 joules of energy (about as much energy as a magnitude 5 earthquake) half way up the THEMIS line. The blast launched two "plasma bullets," huge clouds of protons and elec-

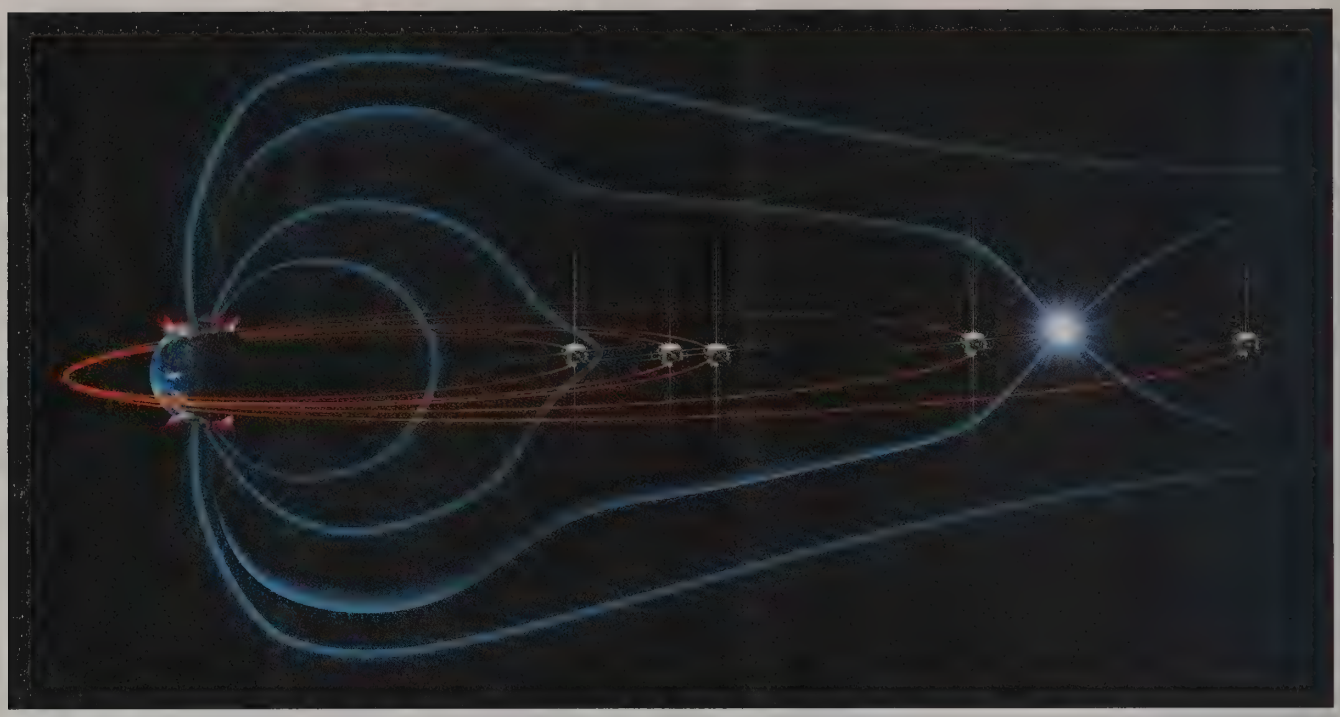

Figure 3. An artist's rendition of the THEMIS satellites lined up inside Earth's magnetotail with an explosion between the fourth and fifth satellites. (Credit: NASA/THEMIS)

trons. One bullet was shot straight toward Earth, and the other away. When the Earth-bound plasma bullet hit Earth, it triggered aurora.

The explosion observed in February 2008 happened inside Earth's magnetic field, but it was actually a release of energy from the Sun. When the solar wind stretches Earth's magnetic field, it stores energy there, in much the same way energy is stored in a rubber band when you stretch it between thumb and forefinger.

Bend your forefinger and *crack!* The rubber band snaps back on your thumb. Something similar happened inside the magnetotail. Over-stretched magnetic fields snapped back, producing a powerful explosion. This process is called "magnetic reconnection," and it is thought to be common in stellar and planetary magnetic fields.

Solving the mystery of where, when, and how substorms occur will allow scientists to construct more realistic substorm models and better predict a magnetic storm's intensity and effects.

"We had bulls-eyes on our solar panels," says THEMIS project scientist David Sibeck of NASA's Goddard Space Flight Center. "Four of the satellites were hit by the Earth-directed cloud, while the opposite cloud hit the fifth satellite." Simple geometry pinpointed the site of the blast between the fourth and fifth satellite, or "about one third of the way to the Moon."

No damage was done to the satellites. Plasma bullets are vast gossamer structures less dense than the gentlest wisp of Earth's upper atmosphere. As they pass by the satellites, THEMIS instruments sample the cloud's internal particles and fields without any damage to satellites.

This peaceful encounter on the small scale of a spacecraft, however, belies the energy deposited on the large scale of a planet. The bullet-shaped clouds are half as wide as Earth and 10 times as long, traveling hundreds of km/sec.

"For the first time, THEMIS has shown us the whole process in action—from magnetic reconnection to aurora borealis," says Sibeck. "We are finally solving the puzzle of substorms."

Scientists directly observe the beginning of substorms using five THEMIS satellites and a network of 20 ground observatories located throughout Canada and Alaska. Launched in February 2007, the five identical satellites line up once every four days along the equator and take observations synchronized with the ground observatories.

Each ground station uses a magnetometer and a camera pointed upward to determine where and when an auroral substorm will begin. Instruments measure the auroral light from particles flowing along Earth's magnetic field and the electrical currents these particles generate.

During each alignment, the satellites capture data that allow scientists to precisely pinpoint where, when, and how substorms measured on the ground develop in space. The explosion observed on February 26, 2008 confirms for the first time that magnetic reconnection triggers the onset of substorms. The discovery supports the reconnection model of substorms, which asserts a substorm starting to occur follows a particular pattern.

The THEMIS mission is scheduled to continue for more than another year, and during that time Angelopoulos expects to catch lots more substorms: "dozens of them," he says. "This will give us a chance to study plasma bullets in greater detail and learn how they can help us predict space weather."

In the next issue, we will continue to look at the results of the intense research pursued throughout sunspot Cycle 23 and into Cycle 24. Feel free to write to me with your questions and observations.

Spring 2009 VHF Propagation

As we move into May, short-distance (only short when compared to long-haul DX of thousands of miles often experienced on the high-frequency spectrum)

propagation opens up in the VHF and sometimes UHF spectrum. These openings provide propagation of radio signals for hundreds of miles and occur almost as if a switch is turned on. This is a mostly summer-time phenomenon called "sporadic-*E*."

Sporadic-*E* (*Es*) is the term given to the mode of propagation where clouds of highly dense ionization develop in the *E*-layer of the ionosphere. These clouds might be very small, but regardless of their size, they seem to drift and move about, making the propagation off these clouds short and unpredictable. It is well documented that *Es* occurs most often in the summer, with a secondary peak in the winter. These peaks are centered very close to the solstices. The winter peak can be characterized as being five to eight times less than the summer *Es* peak.

Ten-meter operators have known *Es* propagation as the summertime "short skip." These "clouds" appear unpredictably, but they are most common over North America during the daylight hours of late spring and summer. *Es* events may last for just a few minutes to several hours, and usually provide an opening to a very small area of the country at any one time.

During periods of intense and widespread *Es* ionization, two-hop openings considerably beyond 1400 miles should be possible on 6 meters. Short-skip openings between about 1200 and 1400 miles may also be possible on 2 meters.

How can we know when a sporadic-*E* opening is occurring? Several e-mail reflectors have been created to provide an alerting service using e-mail. One is found at <http://www.vhfdx.net/sendspots/>. Sporadic-*E* alerting services rely on live reports of current activity on VHF. When you begin hearing an opening, you send out details so that everyone on the distribution list will be alerted that something is happening. They, in turn, join in on the opening, making for a high level of participation. Of course, the greater the number of operators on the air, the more we learn the extent and intensity of the opening. The bottom line is that you cannot work sporadic-*E* if you are not on the air when it occurs.

Speaking of being on the air, check out PropNET on 6 meters. This network of stations monitors the current propagation occurring on a given band, such as 6 meters, in an active way. Rather than just listening for stations, each station sends a beacon that allows the other participating stations to "catch" the beacon and then report the reception in real-time to a map that plots all of the paths that have been "caught." By participating, you add to the working, real-time knowledge of the band's conditions. PropNET is located at <http://www.propnet.org/>.

In addition to live reporting, there is a very powerful resource available on the internet. Check out <http://superdarn.jhuapl.edu/>. SuperDARN (Super Dual Auroral Radar Network) is an international radar network for studying the Earth's upper atmosphere and ionosphere. Using the SuperDARN real-time data 24-hour overview, you can view the day's ionization activity at the northern polar region. You can also view live radar displays of the same area. These graphs help identify *Es* clouds existing in the higher latitudes. One use for this would be the detection of a variation of *Es* known as auroral-*E*.

For a great introduction to mid-latitude sporadic-*E* propagation, visit the AM-FM DX Resource website <http://www.amfmdx.net/propagation/Es.html>.

Tropospheric Ducting

Most propagation on VHF and above occurs in the troposphere. There are a number of well-documented modes of tropospheric propagation. The most common is line-of-sight propagation, which can, depending on the height of the transmitting and the receiving antennas, extend to about 25 miles. When you work simplex FM or FM repeaters in your local area, you are hearing typical line-of-sight tropospheric propagation.

Another possible mode of propagation is by "tropospheric ducting." This term refers to the stratification of the air within the troposphere. These ducts are created by inversion layers formed from solar warming of the ground and the atmosphere immediately above it.

Under perfect conditions, the troposphere is characterized by a steady decrease in both temperature and pressure as height increases. When layers form within this region of air, the refractive index between each layer causes a refraction of VHF and UHF radio waves. If the layers form in just the right way and at the right height, a natural wave-guide is created. A tropospheric duct develops. A VHF signal can be ducted hundreds, if not thousands, of miles. It is common for California stations to work Hawaii stations during tropospheric ducting between the islands and the mainland.

It is worth watching for this mode of propagation. The spring weather season may well be violent and eventful this year, as has already been the case. Advanced visual and infrared weather maps can be a real aid in detecting the undisturbed low clouds between the West Coast and Hawaii or farther during periods of intense subsidence-inversion band openings. This condition occurs also over the Atlantic. There is a great resource on the internet that provides a look into current conditions. Bill Hepburn has created forecast maps and presents them at <http://www.dxinfocentre.com/tropo.html>, including maps for the Pacific, Atlantic, and other regions.

If you know that conditions are favorable for tropospheric ducting in your area, try tuning around the 162-MHz weather channels to see if you can hear stations way beyond your normal line-of-sight reception. It is possible to hear stations over 800 miles away. Amateur radio repeaters are another source of DX that you might hear from the other end of the duct.

These openings can last for several days, and signals will remain stable and strong for long periods during the opening. The duct may, however, move slowly, causing you to hear one signal well for a few hours, to then have it fade out and another station take its place from another area altogether.

Meteor Showers

For most of the spring season, very little meteor activity is expected. June has a possible strong shower, the *Boötids*, but no forecast has been offered for 2009. This shower is active from June 22 through July 2, with the peak occurring on June 27. The hourly visual rate can reach as high as 100 or more. The source of the *Boötids* is periodic comet 7P/Pons-Winnecke. *Boötid* meteoroids hit Earth's atmosphere with a velocity of 18 km/sec (40,000 mph).They are considered slow-moving meteors, making for strong VHF signal reflections off the plasma trails of the burning-up debris. It is worthwhile to give this one a try.

May and July have only minor showers or showers in the Southern Hemisphere. These showers typically have not yielded much radio activity. For more information on these, take a look at <http://www.imo.net/calendar/2009/>.

TE Propagation

A seasonal decline in TE (transequatorial) propagation is expected during May. An occasional opening may still be pos-

sible on VHF. The best time to check for VHF TE openings is between 9 and 11 PM local daylight time. These TE openings will be north-south paths that cross the geomagnetic equator at an approximate right angle.

The Solar Cycle Pulse

The observed sunspot numbers from December 2008 through February 2009 are 0.8, 1.5, and 1.4. Notice that the record of 0.8 for December 2008 is higher than the 0.5 recorded for both July and August of 2008. Statistically, it appears at this time that August 2008 is the lowest point of the minimum between Cycle 23 and Cycle 24. The smoothed sunspot counts for June, July, and August 2008 are 3.2, 2.7 and 2.6, rspectively.

The monthly 10.7-cm (preliminary) numbers from December 2008 through February 2009 are 69.2, 69.8, and 70.1. The smoothed 10.7-cm radio flux numbers for June through August 2008 are 69.2, 68.8, and 68.6.

The smoothed planetary *A*-index (*Ap*) numbers for June through August 2008 are 6.8, 6.6, and 6.2. The monthly readings for December 2008 through February 2009 are 2, 3, and 4.

The smoothed monthly sunspot numbers forecast for May through July 2009 are 12.6, 15.1, and 18.1. These predictions, however, may be too optimistic.

The smoothed monthly 10.7-cm numbers are predicted to be 71.5, 73.3, and 75.4 for the same months. If we take these numbers, we still see that Cycle 24 is upon us. Give or take about 12 points for all predictions.

(Note that these are preliminary figures. Solar scientists make minor adjustments after publishing, by careful review).

Feedback, Comments, Observations Solicited!

I look forward to hearing from you about your observations of VHF and UHF propagation. Please send your reports to me via e-mail, or drop me a letter about your VHF/UHF experiences. I'll create summaries and share them with the readership. Up-to-date propagation information can be found at my propagation center, <http://prop.hfradio.org/> and via cell phone at <http://wap.hfradio.org/>.

Until the next issue, happy weak-signal DXing.

73, Tomas, NW7US

By Rich Arland,* K7SZ

BEGINNER'S GUIDE

All you need to know but were afraid to ask . . .

Creating Your Station Setup

Welcome back to my column! I am writing this from the lanai at my daughter, Gwen's, new home in Tampa, Florida. The weather here in Tampa is in the mid-70s, sunny with a light breeze blowing in from the north. Rough duty, but somebody's gotta do it!

Florida weather is amazing. VHF+ operating is fantastic with all the FM repeaters available, not to mention what seems to be a DX pipeline that appears to terminate here in the middle of the state. While Gwen and her husband, Kyle, are both licensed hams, the CC&Rs of the housing area prohibit external antennas, so their on-the-air operations are relegated to whatever they can do while mobile. However, Florida is basically a flat topography, and a modest 40–50 foot tower and some Yagi antennas would make for some great DXing opportunities for terrestrial weak-signal work from Gwen's new home.

Ops Desks 101

Gwen is not the only one with a new QTH. Pat and I moved from Wilkes-Barre, Pennsylvania to Dacula, Georgia (about 40 miles ENE of Atlanta) just before Thanksgiving last year (2008). With each new QTH come challenges when setting up a ham station. Over the years, traveling the globe with the USAF, I have had ham shacks in closets, spare rooms, basements, attics, bedrooms, hall closets, in our 1978 VW van . . . just about anywhere you could imagine. After 20 years in our home in Pennsylvania, two things became immediately apparent as we prepared for our move south. First, "We have too much junk!" Man, it is mind-blowing how much "stuff" one can accumulate in a 20-year span in one location. Second, no matter how much thought is given to preparing the shack, shacks (like model-railroad layouts) are never finished. There are always improvements of one kind or another that can be made to facilitate operating efficiency, workbench area, test equipment bays, etc. Let's not forget the usual mess of coaxial cable, power cabling, and the occasional open-wire/ladder line. This adventure was no different.

We had lots of land on which to place antennas at our new Georgia location, but the trees were not placed correctly (imagine that!). I liberated one room (a small 9 × 14 foot room in the renovated former garage area) and proclaimed it "*The Shack.*" This will be my last shack, most probably, as I do not relish moving again, and therefore I decided early on to put some creative thought into preparing the room that would house my radios and my operating position. Pat was more than satisfied, as that room was one of two rooms on the very end of the house away from the normal foot traffic and entertainment areas of the new home. That meant that the normal rat's nest of wires, coaxial cables, and power leads, along with all the station accessories that are associated with a well-appointed ham shack, would not be visible to guests (and her) on a regular basis.

Me? *I love* the new shack. It's on a ground floor! The shack in our old home was on the third floor, so establishing a good RF ground (especially on HF) was a bit of an adventure. Gone are the days of having to negotiate several stairways every time I want to "play radio."

My operating position in my last shack was courtesy of Ikea. It had a nice computer-desk/console that I used for over ten years. I really liked that table. Not only was it relatively spacious, I could stack and position equipment for easy use and have a small computer with a 9-inch monitor (thanks to a recycled FedEx Power Ship I picked up at a hamfest) right at my elbow. Although the tiny FedEx computer was only a 386 processor and a very small drive (by today's standards), it worked well for logging, crunching satellite orbital data for working the OSCAR birds, as a packet radio terminal, and for general shack housekeeping chores. Oh, yeah . . . it was cheap, too! I hated to leave that ops desk at the old place, but we had run out of space to pack things in our large Penske truck and small covered trailer during our move.

Working with What You Have

The new shack was crying out for a new operating table/console/desk. My 40-plus years as a ham radio operator had taught me a few lessons regarding making versus buying to include homebrewed equipment, accessories, and operating/test benches. My goal this time around was to be as frugal as possible and assemble my shack using gear I already had on hand—ditto for the antennas and the test bench. This tack was used for several reasons: First, since retiring, Pat and I are living on a fixed income which leaves almost no discretionary funds for hobbies. Second, the state of the economy is, in a word, tenuous at the very least. The less money spent on shack accoutrements, the more money available for upgrading radio gear, test equipment, along with antennas and feedlines.

Initially, Pat and I agreed on spending no more than $99.99 on a new operating bench. Why $99.99? I thought it would be fun to claim that the new shack ops position was procured for under a hundred dollars! After researching various office-supply dealers such as Staples and Office Max, I settled on a nicely styled computer desk/console from Wal-Mart for only $69. On the surface, it initially fulfilled my basic needs and was a nice style (black desk writing surface and shelf over a silver metal framework) and came with a matching black-on-silver three-shelf bookcase for under $70! The great thing about this new desk is that it fits in the corner very nicely, and with a little "remodeling" has more room than initially thought (more on this in a moment).

Don't let FSS get a Foothold in Your Shack!

Flat Surface Syndrome (or FSS) is the scourge of every ham shack and/or work area. FSS is a corollary to Murphy's Law: Anything can and will go wrong at the

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least opportune moment. When dealing with FSS it is important to remember that it is entirely preventable, or so my CPA says. Of course, she is extremely anal retentive and I am not. Ergo, I have a seemingly un-winnable war in the progress of fighting FSS at the new shack.

Exactly what is FSS? In a nutshell, it is the ability of a stationary, flat surface to gather/collect all sorts of "stuff," which in turn makes that flat surface totally incapable of performing its original mission—in this case, functioning as my new operating table.

Dealing with FSS is simple: Keep it uncluttered, which is easier said than done, especially at the "Arland Ranch." However, my CPA (God bless her) has a simple secret: Handle each piece of paper, picture, book, etc, *only once*, putting the offending article of clutter in its proper place (bookshelf, receipt binder, filing cabinet, CD/DVD rack, etc). Again, that is easier said than done. However, with a bit of practice and an overwhelming desire to keep a tidy shack/work area, I have been able to make a huge dent in our ongoing war against FSS.

All kidding aside, if you want to have fun working the world via ham radio, you are going to have to be constantly on guard against the perplexing desire to dump/drop "stuff" wherever is handy. Just keeping a tidy shack area will actually make you want to go into the shack and operate/build. After all, ham radio is a hobby, right? Hobbies should be fun and not drudgery.

The purpose of sharing all of this seemingly nonsensical information is to guide you through the process of initially setting up your shack. Throwing money away on unnecessary "stuff" is almost a criminal act in today's economic upheaval. You want the "biggest bang for your buck," and that is where I come in. Obviously, for our shack the Wal-Mart desk/bookcase was a have-to-buy item, as we did not have an old desk or small table to convert into an operating position. However, if you do have access to a desk/table that you can press into service in your shack, by all means do so. Don't like desks? Have an old door or sliding doors from a bedroom remodeling exercise? These make great op and test benches by just nailing a 2×4 to the wall for rear support and adding a couple of front legs. Cheap, dirty, and fast, not to mention cheap . . . oh, I guess I did already!

KISS: Keep It Simple . . . Silly!

In the immortal words of Commander Scott, Chief Engineer of the starship Enterprise, NCC-1701, "The more complex they make the plumbing, the easier it is to plug up the toilet!" Words to live by. Thanks, Scotty!

This idea not only applies to starships, but to just about everything you do in life. Therefore, some real planning must go into your new shack area before you plop yourself in front of a radio and start calling "CQ."

Using the KISS principle, draw up an outline and a simple wiring diagram of your new shack. Show the routing of power cables, power supplies, coaxial cables, feedlines, etc. This allows you to quickly make changes and upgrades to your shack without a lot of hassle, because you will have diagrams at your immediate disposal.

In the interest of pre-planning, grab a sheet of graph paper or two and lay out your shack and yard in scale on the graph paper. That way you can visualize the shack and proposed antenna farm and position things for optimal efficiency and the shortest feedline runs. Remember, we are now playing in the VHF/UHF arena, so using short feedlines to reduce system losses and keep system noise in check is a must. Unlike HF operating, VHF+ is unique in that the feedline requirements are much more stringent, and that equates to more expensive per foot. By plotting your antenna farm in detail on graph paper, you can accurately calculate the length of feedline runs, so when you are at the point of procuring coaxial cable you won't waste money buying extra feedline you won't use. It's always good to be able to plot the final placement of your gear, antennas, and accessories.

Putting all (and I do mean *all*) of your equipment manuals into a binder(s), along with any modifications and station wiring schematics, will create what we in the military communications arena call a "Station Engineering Manual," which is worth its weight in gold. I have done this for over 20 years, and it is very easy to find manuals when the rig or an accessory goes belly up. Ditto with quickly swapping out gear: It's always nice to know which coaxial cable goes where to prevent miss wiring a piece of expensive gear.

A Station Engineering Manual does not have to be an extensive work of art, just the basics of how your shack is put together and one location for all of your operating and maintenance manuals. Besides, the professional communicators do it for a reason, and their methodology is worth incorporating into your shack. Believe me, you won't regret the effort.

Antennas Anyone?

With a new QTH comes the ever-present task of placing and erecting antennas. Thankfully VHF+ antennas are small, easily handled by one person while erecting them, and they are relatively easy to homebrew with basic hand tools. This is a "win-win-win" situation for the VHF operator.

Our new home was originally constructed in 1987, so it is a relatively new-style construction. One of my primary missions is to ensure this shack is going to be not only functional, but will look great, too.

Having used inside antennas before at several locations, I did a quick survey of our new attic area. I was surprised to find that it was totally empty (except for insulation and power wiring), and there was a lot of headroom at the apex of the roof—perfect for an indoor dipole for HF. If the house was only 5 feet longer, a full-size 40-meter halfwave dipole would fit perfectly. This time, however, I had to bend each end down to secure the last two feet of each end of the dipole. I am feeding this HF dipole with 300-ohm ladder line so it will perform over the majority of the HF spectrum.

I know, I know . . . you really don't care about my HF antennas, but you want to know how I tackled the VHF+ antenna situation. OK, here goes.

Initially I had decided to run all the RF feedlines down to the shack inside the walls and not just bore holes in the side of the house (similar to how the satellite TV installers do). Of course, there area several commercial vendors, MFJ is one, that offer a through-window antenna feed through. I had one and it was more than adequate for the job at hand. However, this time I wanted to do a more professional installation by running the RF cabling from the roof area down to the shack inside the walls. In the attic, I drilled down (after several trips up and down the ladder) and hit the header 2×4 dead center with a 1-inch wood bit. After punching four holes in the wall header, I used a wire "snake" to bring up four runs of masonry twine from inside the shack via a rectangular opening in the shack wall that I had previously cut through the dry wall. Each piece of twine was secured to a length of either RG-213 or Belden 9913/F7 coaxial feedline. An additional run of 300-ohm transmission line for the HF dipole was

added, as was a run of RG-58/U for an indoor 2-meter beam for FM repeater work.

I know what you're thinking: "What are you going do with that big rectangular hole in your shack wall, Arland?" That is where an 8×8 piece of 1/8-inch aluminum comes in. I had this piece of metal kicking around the shack for a couple of years, so after drilling several 5/8-inch holes to accommodate SO-239 feed-through connectors, some insulated jacks for the ladder line, and one ground lug, I secured this to the wall using dry-wall anchors and screws. The coaxial cables come in from the roof, down the wall of the shack, and terminate in PL-259s behind the panel. These are mated with the SO-239 feed-throughs and a coaxial jumper is then attached to the shack side of the feed-throughs, going to a specific radio set. All in all, a very nice, tidy, and professional-looking installation, and easy to access for more feedlines, should the need arise. Once I get the tripod on the roof with the rotator and the VHF stack functional, I will bring the rotator cabling down the wall just like the feedlines and terminate it in a Molex connector on the aluminum panel. The rotator control box will plug into the Molex connector to finish the installation.

Antenna Thoughts

Initially my idea was to obtain an 8-foot Glen Martin roof tower on which to mount my VHF+ and OSCAR antennas. Then reality set in and I realized that it would be a while before I could afford to implement this antenna farm. In keeping with the "less is more" concept, I decided to use what I had on hand to get some VHF+ antennas in the air before the ARRL VHF Sweepstakes in January.

Six 4-foot sections of fiberglass military antenna mast affixed to the back porch roof joists, and three Halo antennas for 6, 2, and 70 cm would at least get me on the air for the contest. Although my ultimate VHF+ stack would consist of 5-over-5 for 2 meters, a 3-element 6-meter Yagi, and a Quagi for 70 cm, sitting atop the roof, I was quite content to erect these three omni antennas as an interim measure. Total cost for this down-and-dirty VHF+ installation: $0.00, as everything was on-hand, left over from various other antenna installations over the years. How well does this antenna stack work? The ARRL VHF Sweepstakes will give me a good indication of efficiency. In the meantime, I will be saving my pennies for that Glen Martin roof-tower! 73, Rich, K7SZ

CQ's 6 Meter and Satellite WAZ Awards

(As of March 1, 2009)

By Floyd Gerald,* N5FG, CQ WAZ Award Manager

6 Meter Worked All Zones

No.	Callsign	Zones needed to have all 40 confirmed
1	N4CH	16,17,18,19,20,21,22,23,24,25,26,28,29,34,39
2	N4MM	17,18,19,21,22,23,24,26.28.29,34
3	JI1CQA	2,18,34,40
4	K5UR	2,16,17,18,19,21,22,23,24,26,27,28,29,34,39
5	EH7KW	1,2,6,18,19,23
6	K6EID	17,18,19,21,22,23,24,26,28,29,34,39
7	K0FF	16,17,18,19,20,21,22,23,24,26,27,28,29,34
8	JF1IRW	2,40
9	K2ZD	2,16,17,18,19,21,22,23,24,26, 28,29,34
10	W4VHF	16,17,18,19,21,22,23,24,25,26,28,29,34,39
11	GØLCS	1,6,7,12,18,19,22,23,28,31
12	JR2AUE	2,18,34,40
13	K2MUB	16,17,18,19,21,22,23,24,26,28,29,34
14	AE4RO	16,17,18,19,21,22,23,24,26,28,29,34,37
15	DL3DXX	18,19,23,31,32
16	W5OZI	2,16,17,18,19,20,21,22,23,24,26,28,34,39,40
17	WA6PEV	3,4,16,17,18,19,20,21,22,23,24,26,29,34,39
18	9A8A	1,2,3,6,7,10,12,18,19,23,31
19	9A3JI	1,2,3,4,6,7,10,12,18,19,23,26,29,31,32
20	SP5EWY	1,2,3,4,6,9,10,12,18,19,23,26,31,32
21	W8PAT	16,17,18,19,20,21,22,23,24,26,28,29,30,34,39
22	K4CKS	16,17,18,19,21,22,23,24,26,28,29,34,36,39
23	HB9RUZ	1,2,3,6,7,9,10,18,19,23,31,32
24	JA3IW	2,5,18,34,40
25	IK1GPG	1,2,3,6,10,12,18,19,23,32
26	W1AIM	16,17,18,19,20,21,22,23,24,26,28,29,30,34
27	K1LPS	16,17,18,19,21,22,23,24,26,27,28,29,30,34,37
28	W3NZL	17,18,19,21,22,23,24,26,27,28,29,34
29	K1AE	2,16,17,18,19,21,22,23,24,25,26,28,29,30,34,36
30	IW9CER	1,2,6,18,19,23,26,29,32
31	IT9IPQ	1,2,3,6,18,19,23,26,29,32
32	G4BWP	1,2,3,6,12,18,19,22,23,24,30,31,32
33	LZ2CC	1
34	K6MIO/KH6	16,17,18,19,23,26,34,35,37,40
35	K3KYR	17,18,19,21,22,23,24,25,26,28,29,30,34
36	YV1DIG	1,2,17,18,19,21,23,24,26,27,29,34,40
37	KØAZ	16,17,18,19,21,22,23,24,26,28,29,34,39
38	WB8XX	17,18,19,21,22,23,24,26,28,29,34,37,39
39	K1MS	2,17,18,19,21,22,23,24,25,26,28,29,30,34
40	ES2RJ	1,2,3,10,12,13,19,23,32,39
41	NW5E	17,18,19,21,22,23,24,26,27,28,29,30,34,37,39
42	ON4AOI	1,18,19,23,32
43	N3DB	17,18,19,21,22,23,24,25,26,27,28,29,30,34,36
44	K4ZOO	2,16,17,18,19,21,22,23,24,25,26,27,28,29,34
45	G3VOF	1,3,12,18,19,23,28,29,31,32
46	ES2WX	1,2,3,10,12,13,19,31,32,39
47	IW2CAM	1,2,3,6,9,10,12,18,19,22,23,27,28,29,32
48	OE4WHG	1,2,3,6,7,10,12,13,18,19,23,28,32,40
49	TI5KD	2,17,18,19,21,22,23,26,27,34,35,37,38,39
50	W9RPM	2,17,18,19,21,22,23,24,26,29,34,37
51	N8KOL	17,18,19,21,22,23,24,26,28,29,30,34,35,39
52	K2YOF	17,18,19,21,22,23,24,25,26,28,29,30,32,34
53	WA1ECF	17,18,19,21,23,24,25,26,27,28,29,30,34,36
54	W4TJ	17,18,19,21,22,23,24,25,26,27,28,29,34,39
55	JM1SZY	2,18,34,40
56	SM6FHZ	1,2,3,6,12,18,19,23,31,32
57	N6KK	15,16,17,18,19,20,21,22,23,24,34,35,37,38,40
58	NH7RO	1,2,17,18,19,21,22,23,28,34,35,37,38,39,40
59	OK1MP	1,2,3,10,13,18,19,23,28,32
60	W9JUV	2,17,18,19,21,22,23,24,26,28,29,30,34
61	K9AB	2,16,17,18,19,21,22,23,24,26,28,29,30,34
62	W2MPK	2,12,17,18,19,21,22,23,24,26,28,29,30,34,36
63	K3XA	17,18,19,21,22,23,24,25,26,27,28,29,30,34,36
64	KB4CRT	2,17,18,19,21,22,23,24,26,28,29,34,36,37,39
65	JH7IFR	2,5,9,10,18,23,34,36,38,40
66	KØSQ	16,17,18,19,20,21,22,23,24,26,28,29,34
67	W3TC	17,18,19,21,22,23,24,26,28,29,30,34
68	IKØPEA	1,2,3,6,7,10,18,19,22,23,26,28,29,31,32
69	W4UDH	16,17,18,19,21,22,23,24,26,27,28,29,30,34,39
70	VR2XMT	2,5,6,9,18,23,40
71	EH9IB	1,2,3,6,10,17,18,19,23,27,28
72	K4MQG	17,18,19,21,22,23,24,25,26,28,29,30,34,39
73	JF6EZY	2,4,5,6,9,19,34,35,36,40
74	VE1YX	17,18,19,23,24,26,28,29,30,34
75	OK1VBN	1,2,3,6,7,10,12,18,19,22,23,24,32,34
76	UT7QF	1,2,3,6,10,12,13,19,24,26,30,31
77	K5NA	16,17,18,19,21,22,23,24,26,28,29,33,37,39
78	I4EAT	1,2,6,10,18,19,23,32
79	W3BTX	17,18,19,22,23,26,34,37,38
80	JH1HHC	2,5,7,9,18,34,35,37,40.
81	PY2RO	1,2,17,18,19,21,22,23,26,28,29,30,38,39,40
82	W4UM	18,19,21,22,23,24,26,27,28,29,34,37,39
83	I5KG	1,2,3,6,10,18,19,23,27,29,32.
84	DF3CB	1,2,12,18,19,32
85	K4PI	17,18,19,21,22,23,24,26,28,29,30,34,37,38,39

*17 Green Hollow Rd., Wiggins, MS 39577; e-mail: <n5fg@cq-amateur-radio.com>

By Mark Thompson, WB9QZB

DIGITAL RADIO

Digital Technology on VHF, UHF, and Microwaves

Digital Modes
They're Not Just About Data Anymore

Until recently, when ham radio operators considered operating the digital modes, that usually meant some form of data transmission.

Hams became involved in digital in the late 1040s by using surplus Baudot-format mechanical teletype equipment. The teletype machines were large, heavy, and noisy. They printed on yellow roll-type paper. Some machines had the optional paper tape punch. With it you could record material in advance on paper tape. The paper tape could then be transmitted at full speed later. This was especially useful for bulletin transmissions.

Ham radio teletype was called RTTY. RTTY equipment was used on HF to make keyboard QSOs and receive bulletins, such as those from the ARRL. RTTY had no error correction, so signal fading and noise on HF could cause many errors.

In the 1970s some hams interfaced their RTTY equipment to 2-meter FM transceivers to monitor messages from local hams in a mode called *auto-start*. In some areas FM repeaters were used to extend the range of RTTY auto-start activity and to disseminate bulletins.

For those more than 30 years, Baudot RTTY is what digital meant in ham radio. Up until the early the 1980s five-bit Baudot was the only mode the FCC allowed on ham radio. Baudot only contained upper-case letters. You might have seen a copy of a Western Union telegram or an AT&T Telex printed using Baudot.

However, with the advent of personal computers, in the 1970s hams wanted to use ASCII. ASCII code has more characters, including lower case and additional punctuation. Hams appealed to the FCC, which approved the use of ASCII in the early 1980s. They used more modern teletype and computer terminals to transmit and receive ASCII RTTY. Some hams at the time also developed programs for the early PCs to transmit and receive both Baudot and ASCII RTTY.

In the 1980s a group of hams invented packet radio, which used the ASCII code. Packet radio required that a packet be received correctly or it was retransmitted. On the VHF/UHF bands this led to very accurate transmission of data. However, noise and signal fading on HF caused packets to be retransmitted over and over again, resulting in the 300-baud transmission speed dropping dramatically.

Hams developed BBS (bulletin board systems) accessible on VHF and UHF in most areas of the country. Terrestrial forwarding networks were developed to forward e-mails across the country and the world. HF gateways were developed to allow long-distance forwarding of messages between BBSes.

In the late 1980s and early 1990s many of the packet radio TNCs (terminal node controllers) were extended to include other ASCII-based text modes such as AMTOR, Pactor, and G-TOR. Modes such as AMTOR had error correction, which RTTY did not.

In the mid-1990s the internet became available. Many hams abandoned packet radio to use the internet. As a result, the BBSes and forwarding networks fell into disuse and many were taken off the air.

In the late 1990s major developments occurred in ham radio data modes. PSK31 was developed. It performed much better in weak-signal conditions on HF than the other data modes. In addition, it was the first mode to use a PC soundcard with a computer program and did not require dedicated hardware customized for a specific mode.

Over the next few years numerous soundcard data modes were developed for many different uses. Eventually hams began to develop digital voice modes using PC programs and soundcards. These are the typical digital voice modes used on HF radio today.

HF digital voice modes currently are evolving. HF has many unique, or more pronounced, problems than VHF/UHF, such as QRN, QRM, fading, and multipath. These are the same problems that historically caused problems for RTTY. As the technologies advance, I expect many of these problems will be solved. In my opinion, an SDR radio should be an ideal platform for the deployment of HF digital voice modes, since it can be easily upgraded in software as technology improves and eliminates the requirement of a PC with a soundcard to use digital voice. Building digital voice into as SSB or FM transceiver would cause digital voice to become much more popular and easy to use.

VHF/UHF Digital Voice

On VHF and UHF digital voice developed differently. A company named DVSI developed and patented vocoder technology using the names IMBE and AMBE. DVSI's digital technologies were adopted by the public-safety organization APCO and commercial manufacturers such as Motorola, Kenwood, Vertex, and ICOM. APCO has designated P25 as a standard for digital voice transmission in the pubic-safety world. P25 can be used in both simplex and with a traditional repeater. P25 can also be the basis of expensive and complicated trunking technologies which conserve spectrum and provide new capabilities.

Early adopters of digital voice on VHF/UHF often used surplus P25 radios. While P25 has the inherent advantage of all digital voice modes—the lack of path noise—the radios tended to be expensive and were not easily frequency-agile, since most did not have a VFO. P25 radios and repeaters are designed for public safety, not ham radio, and therefore do not have some capabilities desirable in ham radio, such as callsign identification of radio transmissions and built-in internet networking.

The first ham radio rig designed for

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e-mail: <wb9qzb@arrl.net>

ham radio was produced by Alinco. However, since it did not have a compatible repeater or other system capabilities, it never gained much popularity.

Enter D-STAR

A few years ago the JARL in Japan developed the open protocol D-STAR. ICOM was the first manufacturer to make D-STAR radios, repeaters, and an internet-based gateway to connect users and repeaters together worldwide. Any manufacturer can make D-STAR radios, and it is expected another will enter the market.

Since all D-STAR radio transmissions are uniquely identified by a callsign programmed into the radio, transmissions can be routed by the system. In addition, the D-STAR protocol and radios allow for concurrent transmission of low-speed, approximately 1-kb/sec ansynchronous data with a digital voice transmission. This low-speed data capability built into every D-STAR digital voice radio allows for the transmission of GPS data, text messages, small text files and low-resolution web-cam pictures. Hams have extended the D-STAR environment to include repeater-to-repeater linking such as IRLP and access to the D-STAR network from a PC using a DV-Dongle. More technologies have been developed to adapt narrow-band analog FM rigs with a 9600-baud data port to transmit and receive D-STAR.

Advantages of Digital Voice

Digital voice on both HF and VHF/UHF has the advantages of narrower bandwidth and no path noise. As a signal gets weaker or fluctuates, it does not get noisy like an analog FM signal does. This results in greater effective range on VHF/UHF than traditional FM. Many hams who have never used digital voice mistakenly believe digital voice can't work as well as FM because their cell phones get garbled when weak. There are several recordings available that compare weak digital voice to weak FM. The weak digital voice signal is clear with no noise, whereas the weak FM signal has a lot of path noise to the extent that the voice audio can hardly be heard.

Where to go to Learn More

At the ARRL/TAPR DCC (Digital Communications Conference) in 2008 in Chicago digital voice was well covered. We had presentations in both the technical and introductory tracks about HF and VHF/UHF digital voice. We had the first-ever D-STAR get-together on Friday evening with many D-STAR technology innovators making presentations. At the DCC, D-STAR 70-cm and 23-cm digital voice repeaters were running connected to the internet gateway for use by DCC attendees.

I encourage everyone who has an interest in digital voice and data communications to attend both the Dayton Hamvention® and the Digital Communication Conference.

At the Hamvention®, TAPR sponsors a digital forum and a joint AMSAT/TAPR evening banquet. DARA (Dayton Amateur Radio Association), sponsor of the Hamvention®, now has D-STAR repeaters on the air in Dayton, and ICOM demonstrates D-STAR radios and repeaters at the Hamvention®.

The DCC will again be back in Chicago in 2009. It is a great way for both experienced and new operators of the digital modes to learn more about the technologies. If you have experience using digital data or voice technology or innovating a new digital technology, please consider submitting a paper to be included in the *Proceedings* and perhaps present your paper at the DCC. You can learn more about the 2009 DCC at <http://www.tapr.org/dcc.html>.

I look forward to seeing many of you in May at the Dayton Hamvention® at the digital forums, at the DCC in Chicago in September 2009, and on the D-STAR worldwide network using digital voice.

73, Mark, WB9QZB

By Dr. H. Paul Shuch,* N6TX

DR. SETI'S STARSHIP

Searching For The Ultimate DX

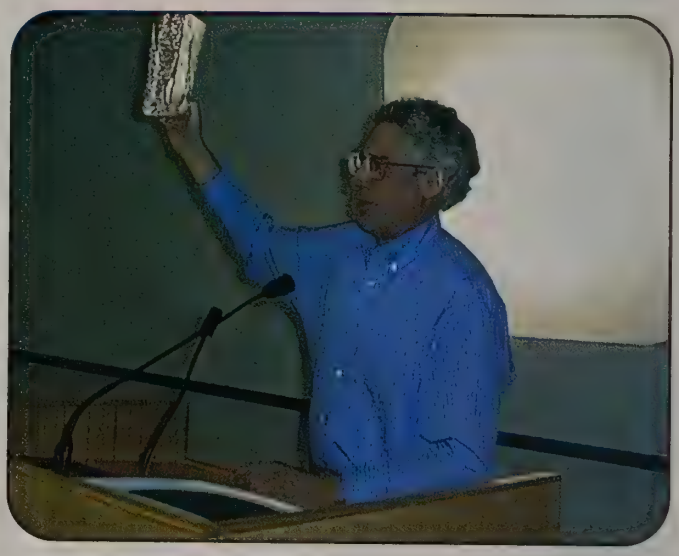
Betting on SETI Success

If I were a betting man (I am) and had money to put down on the table (I don't), I'd wager that our first encounter with alien intelligence will be via interstellar microwave contact. Perhaps that's because of my ham radio background. It just stands to reason that photons are not only the fastest spaceship in the universe, but also the cheapest. Microwave photons (the substance of electromagnetic communications) are both massless and relatively energetic. They traverse the interstellar medium at the fastest speed that Einstein would allow, relatively unimpeded, while carrying information from point A to point B. For practical purposes, the power requirement for transiting the interstellar gulf can be measured in kilowatts.

Contrast this with interstellar flight, our most likely alternative search strategy. Fermions (the stuff of which we, and our machines, are made) have mass, and both Newton and Einstein agree that accelerating mass to great velocity requires great energy. Thus, sending a cosmic message in a physical bottle will require not kilowatts, but billions of Terawatts of energy. No advanced technology that I can imagine is capable of overcoming this barrier. As Mr. Scott (my favorite engineer) told Kirk in *Star Trek*, "Captain, I canna' change the laws of nature."

Allen Tough believes otherwise. You have met Prof. Tough previously in these columns. He's the futurist from the University of Toronto who founded Invitation to ETI (extraterrestrial intelligence), the web-based project designed to stimulate dialog between us and our cosmic companions. Allen envisions an advanced nano-robotic technology that will permit low-cost, possibly self-replicating, autonomous interstellar probes. Based upon the undisputable fact that humanity is well on its way to developing such technology, Allen reasons that a more advanced civilization by now will have launched a fleet of such miniature robot probes, some of which may already have reached our solar system. It is with these probes, rather than their creators, that Allen is betting we will first communicate.

Allen Tough and I have long debated whether it is interstellar photons, or interstellar probes, that will give us our first taste of interstellar contact. Now comes Long Bets (www.longbets.org), the Arena for Accountable Predictions, a web-based wagering facility launched by the futures-oriented Long Now Foundation. The purpose of Long Bets is to improve long-term thinking. Long Bets is a public arena for enjoyably competitive predictions, of interest to society, with philanthropic money at stake. The Long Now Foundation furnishes the continuity to see even the longest bets through to public resolution. Its website provides a forum for discussion about what may be learned from the bets and their eventual outcomes. Allen threw down the gauntlet at Long Bets, and I picked it up. His prediction: "Evidence of extraterrestrial intelligence within the solar system will be confirmed before evidence from several light-years away."



It may indeed look like a tissue box covered with aluminum foil, but the object Allen Tough is holding up, he assures us, is a prototype interstellar robotic nano-probe.

Even though I personally disagree, there is some logic behind Allen's prediction. Here is his rationale:

> Most SETI scientists agree that any ETI we detect will likely be thousands or millions of years ahead of us (because our sun and our science are so young). Such an advanced society will likely have the *capacity* to build and launch cheap, smart autonomous probes to explore the galaxy. This statement is supported by our recent theoretical and engineering advances in robotics (Ray Kurzweil, Hans Moravec), molecular manufacturing (nanotechnology), and interstellar propulsion (beam propulsion and even more radical possibilities). Also, an advanced society will likely be *motivated* to send out exploratory probes, judging by our own society, which sends spacecraft to explore everything within reach.
>
> If such a probe were sent a few centuries ago to explore Earth, it would likely be here by now. We might stumble on it somewhere on Earth by accident. Or we might find it through the ongoing monitoring carried on by scientists, security and intelligence agencies, and the military. Or one report in the flood of UFO and abduction reports might turn out to be a genuine alien. Or one of our space exploration programs might find some alien artifact somewhere in the solar system. Or ETI might reply to the Invitation to ETI issued by 100 scientists, artists, and others at <http://www. ieti.org>. (As the founder and Chief Scientist of this innovative SETI project, I am naturally optimistic about its chances of success.)

I've gone on record as betting against my respected colleague, not because I think Allen is wrong about interstellar probes, but

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e-mail: <n6tx@setileague.org>

because we don't yet know how to detect them. It's a matter of instrumentation. Although we've gotten very good at intercepting electromagnetic waves, our record for detecting even nearby natural space debris is not too stellar (pun completely intentional).

Although I do not at all question the likely existence of interstellar probes within our solar system, I consider interstellar electromagnetic (EM) leakage (or, if we are extremely fortunate, deliberate radio or optical beacons) much easier to detect with our present level of technology. Thus, selectivity factors in the instrumentation favor detection of interstellar EM artifacts first. (As our techniques improve, the odds of detection will ultimately shift. Therefore, I guess by betting on interstellar EM signals, I'm siding with those who believe contact will occur in the short term.)

Allen has argued (most convincingly, I might add) that any super-smart alien robot that is sophisticated enough to come here will be quite capable of initiating contact, or even of responding to our joint invitation at <http://ieti.org>. Although I certainly hope this is the case, it does put us in the role of passive communications partners, waiting for ETI to take the first step. Being no wallflower, I personally advocate a more proactive approach, preferring to put our eventual entry into the galactic community squarely in the hands of humanity. Assuming the existence of extraterrestrial intelligence (without it, this bet can neither be won nor lost), traditional interstellar SETI makes us solely responsible for the success or failure of our efforts. Should ETI decide to step in and shortcut the process, I for one will be delighted at the contact, although dismayed that my friend Allen will end up winning this bet!

Prof. Tough and I each have put a couple of hundred dollars on the line with Long Bets. The rules of Long Bets specify that once a bet is settled, it is a designated charity, rather than the parties to a wager, that will receive the funds on deposit. Allen has generously stated that if he prevails in his bet, the winnings will be contributed to the nonprofit SETI League, a ham radio organization near and dear to my heart. In putting up money against him, I too have designated that worthy grassroots organization as recipient of any funds, once the bet is settled. That way, either way, this will be a no-lose bet! 73, Paul, N6TX

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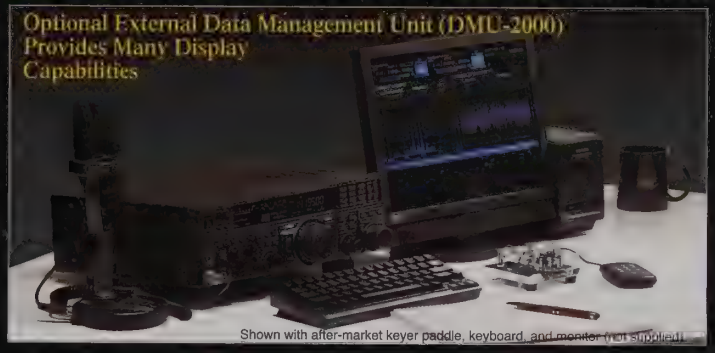

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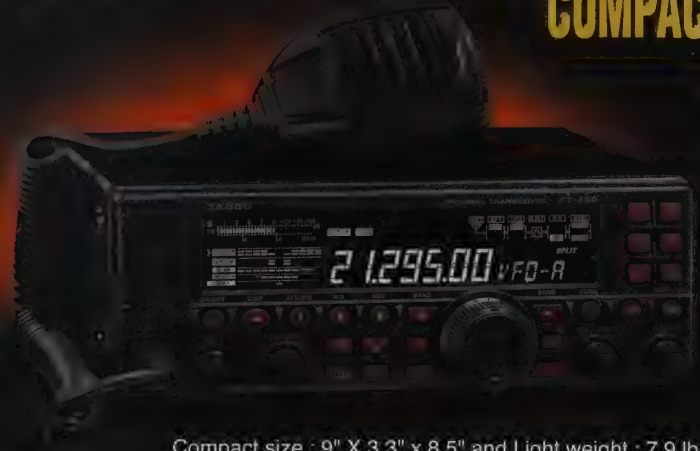

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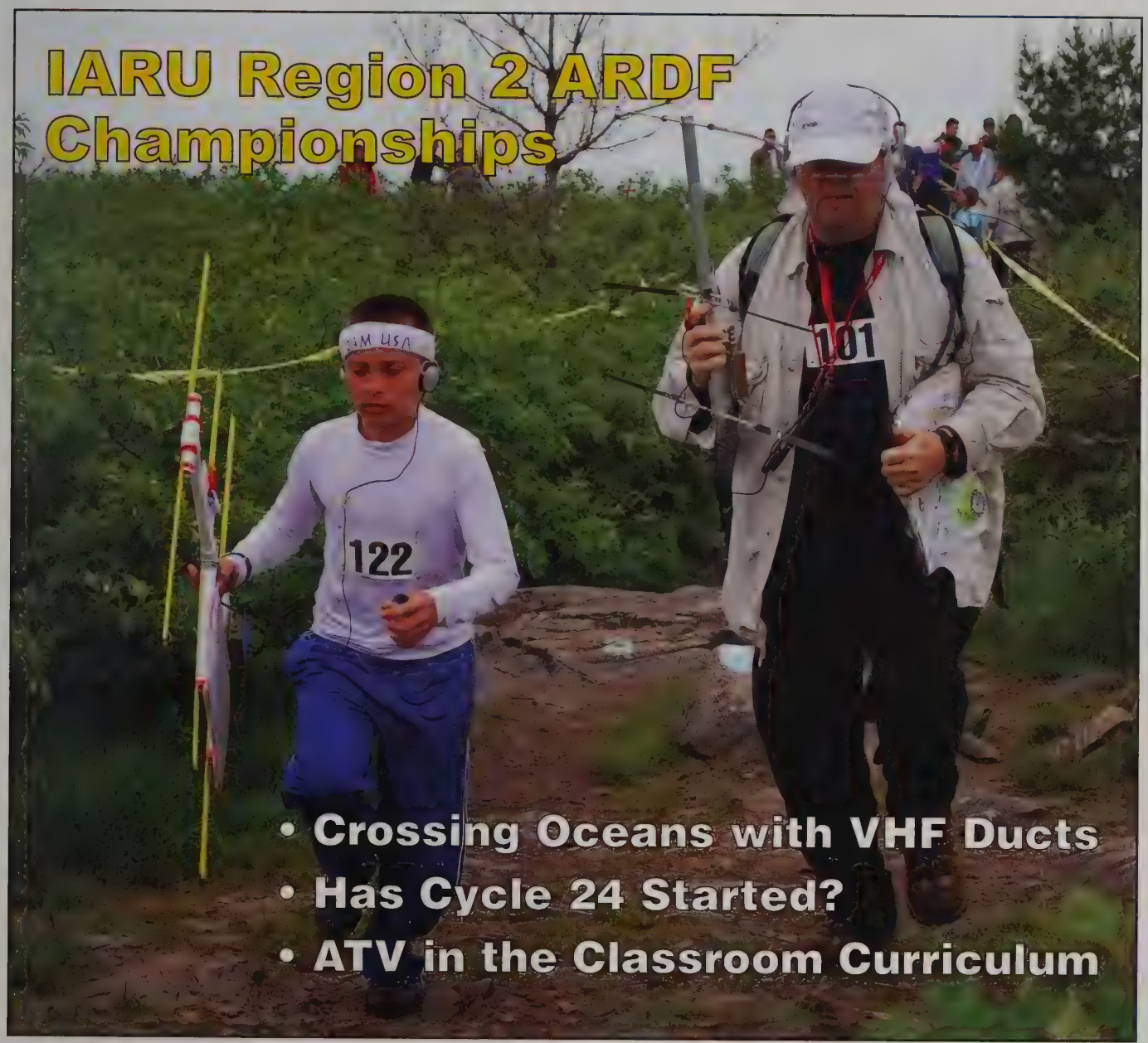

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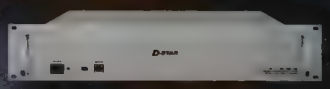

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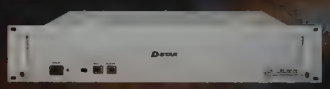

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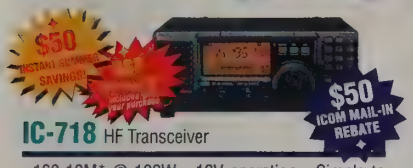

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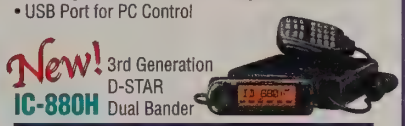

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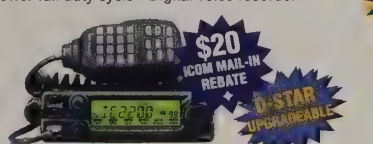

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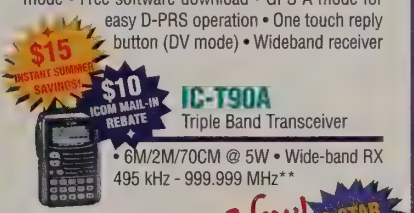

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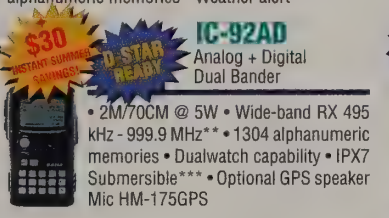

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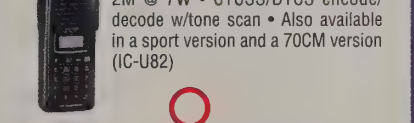

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Summer 2009
Vol. 13 No. 2

FEATURES

COLUMNS

DEPARTMENTS

On The Cover: The 2009 ARDF Championships for the USA and IARU Region 2 were held in the Boston area. Shown in the 2-meter starting corridor are Addison Bosley (left) and Bill Smathers, KG6HXX. For details see the "Homing In" column on p. 46. (Photo by Joe Moell, KØOV)

CQ VHF Ham Radio Above 50 MHz

LINE OF SIGHT

A Message from the Editor

The World Wide Web: The Double-Edged Sword

It was in the mid-1980s when 28.885 MHz was hopping with reports of real-time 6-meter propagation. When the 6-meter band wasn't open, that frequency became an intercom of sorts—a worldwide intercom. One could announce one's callsign and get an instant response from someone else on the other side of the world.

As the day went on the propagation traveled around the world. For me in Oklahoma, in the morning I could work into Europe and Africa with my TS-440 and Outback antenna for my car. In the evening it was the South Pacific that was open to me.

Now, though, <http://www.dxinfocenter.com> and <http://www.vhfdx.net> are among the most popular "intercoms." Add to these propagation tools Twitter, You Tube, USTREAM, Facebook, and Spy (http://spy.appspot.com/), to name a few, and you have pretty much covered the social network websites that are broadcasting real-time information about whatever you want. Speaking of Twitter, you can find me under the name: JoeN6CL. Add to these social networking sources your own blog on your own website and you have the world covered.

You can post a propagation report to VHFDX.net at the same time you can post a 140-character message to Twitter and the world knows about who you are working and what your QTH is. Imagine a DXpedition posting to Twitter stating who a team is working and on what bands! Regarding your QTH, dare I mention APRS? How about D-STAR?

The double-edge of the sword of the World Wide Web is that people with whom you wish to have nothing to do bother you with spam and other nuisances. Additionally, time spent on the WWW is not time spent on the air. Nevertheless, it seems that the availability of instant worldwide communications outweighs the downsides.

The Future of Our Youth

In this issue's "ATV" column Miguel Enriquez, KD7RPP, discusses Jhovana Peralta, KF7DDD, who is a student in his school. He shares how she will play a leading role in this fall's experimental class "Amateur Radio, Space and Wireless Technologies." He speaks very highly of her and hopes that she will be able to attend a prestigious university in two years when she graduates. Jhovana has made her parents proud, being the first in her family who plans to attend college.

In the "Homing In" column Joe Moell, KØOV, discusses Addison Bosley of Erlanger, Kentucky, who is the grandson of Dick Arnett, WB4SUV. At age 11, Addison was the youngest competitor in the IARU Region 2 ARDF Championships this year. Addison earned gold medals in the M19 category on both bands.

I've written about my passion for youth here before, and I reiterate my point: The future of our hobby lies in our youth. Knowing that our future is in the hands of our youth compels me to want to provide every means of encouragement possible for them to succeed. When you have two wonderful examples such as Jhovana and Addison, you cannot help but cheer for our future.

If you have a story about a youth in amateur radio, please share it with me. I love to present their stories here in *CQ VHF*.

Innovations and Insights

For those of us who were able to attend the HSMM seminar at HamCom in Plano, Texas, we were treated with an exciting presentation on the latest in HSMM. MESH networking is a form of digital communications that is designed to route data, voice, and instructions between nodes. This routing is accomplished by continuous connections and reconfiguration around broken or blocked paths by "hopping" from node to node until the destination is reached. Thus, HSMM-MESH® networking is using HSMM in a mesh network.

John Champa, K8OCL, led the two-hour forum with an introduction to the difference between WiFi and HSMM. He highlighted the need for developing a means of digital transmission that is significantly faster than the technology that existed in the aftermath of 9/11. He also spoke of how under-utilized the VHF-plus ham bands have been. Additionally, he discussed the need to update our emergency communications so as to bring ourselves in line with the rest of the world.

With the migration of commercial television to digital, we amateur radio operators are also a bit behind the curve. John covered amateur digital video and compared it with what has just gone away, analog NTSC standard television.

Glenn Currie, KD5MFW, followed John with a presentation on HSMM-MESH®. Glen discussed the city-wide deployment of HSMM-MESH® in the Austin, Texas area. Austin was picked for the deployment because of its central location and the critical role that it played in recent hurricanes.

John's extensive coverage of HSMM-MESH® begins on page 38.

Regarding insights is Dave Petersen, N7BHC, who is doing pioneering work on unraveling transoceanic propagation. His article on subsidence temperature inversions begins on page 6.

Another insightful article in this issue was written by Mark Morrison, WA2VVA. The connection between amateur radio and the cosmos has long been known. In Part 1 Mark discusses some of the early pioneers in this curious connection with our hobby.

What We are Working On

Echoes of Apollo was a great success. Among the highlights were the QRP EME contacts between the 26-meter Mt. Pleasant dish in Tasmania, Australia, and the dishes in Switzerland and The Netherlands. Extensive coverage of the successes is planned for a future issue of *CQ VHF* magazine.

While I was at Dayton, I came across a display concerning the South Carolina Healthcare Emergency Amateur Radio Team and its Statewide Communication Network (see: <http://www.scheart.us>). This display was within the ARRL area.

I was so impressed with the team's statewide network of repeaters that tie into hospitals that I asked them to write an article about their operation and how it came into existence. For me, I am interested in how they were able to get tower space on their statewide educational television network as a means of knowing if it is possible to replicate this network in Oklahoma using our statewide educational television network. I look forward to sharing their articles in a future issue.

And Finally . . .

Because of the time sensitivity of several of the articles in this issue, we are holding over articles on working 2 meters terrestrially, using batteries in emergency communications, and emergency communications and AMSAT. We have lots in this issue and lots in store for future issues of this, your source for the great things that are happening on the VHF-plus ham bands. 73 de Joe, N6CL

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Crossing Oceans with VHF Ducts

Subsidence Temperature Inversions

In an effort to cross oceans with amateur radio signals, N7BHC has been working tirelessly to find propagation paths where no amateur radio signal seemingly has gone before. Here he discusses subsidence temperature inversions and how they may be used for making record-establishing transoceanic QSOs.

By Dave Pedersen,* N7BHC

VHF and UHF operators have used temperature inversions and the ducting propagation they create for many decades. There are several types of ducts that occur over both land and sea. These include frontal, evaporative, and subsidence ducts. Surface ducts reach all the way to the Earth's surface, while elevated ducts do not.

Ducts are caused by a change in the refractive qualities of the medium through which the radio signal is traveling—in this case, the lower atmosphere. The key mechanism is a temperature inversion. The sun's energy heats the Earth, which in turn heats the air in contact with it. Thus, the warmest air is usually at the Earth's surface. The air progressively cools as the altitude increases. This is shown in figure 1(A). The solid line is temperature, while the dashed line is humidity.

Under certain conditions, the temperature stops cooling and increases by as much as 5–15 degrees F over just a few hundred feet elevation. This is a *temperature inversion* and forms the top of the *trapping layer,* or duct. A temperature inversion is illustrated in figure 1(B). Note that in the temperature inversion, the humidity can decrease sharply. The humidity change actually has a much greater effect on the index of refractivity than does the temperature.

The keen observer will notice a small temperature inversion almost at the surface in figure 1(A). This is probably an evaporative duct, suitable for microwave paths in the 3–24 GHz range. Evaporative ducts are very reliable across the oceans and have the potential for very long-distance contacts. This propagation mode is worthy of a lot more amateur research for stations literally at the beach. Very little work has been done on this topic for point-to-point communications, and it may be covered in a future article.

This article is not an exhaustive explanation of temperature-inversion creation and physics. The reader is encouraged to conduct further research online. Several web pages are referenced in this article and in the references section at the end.

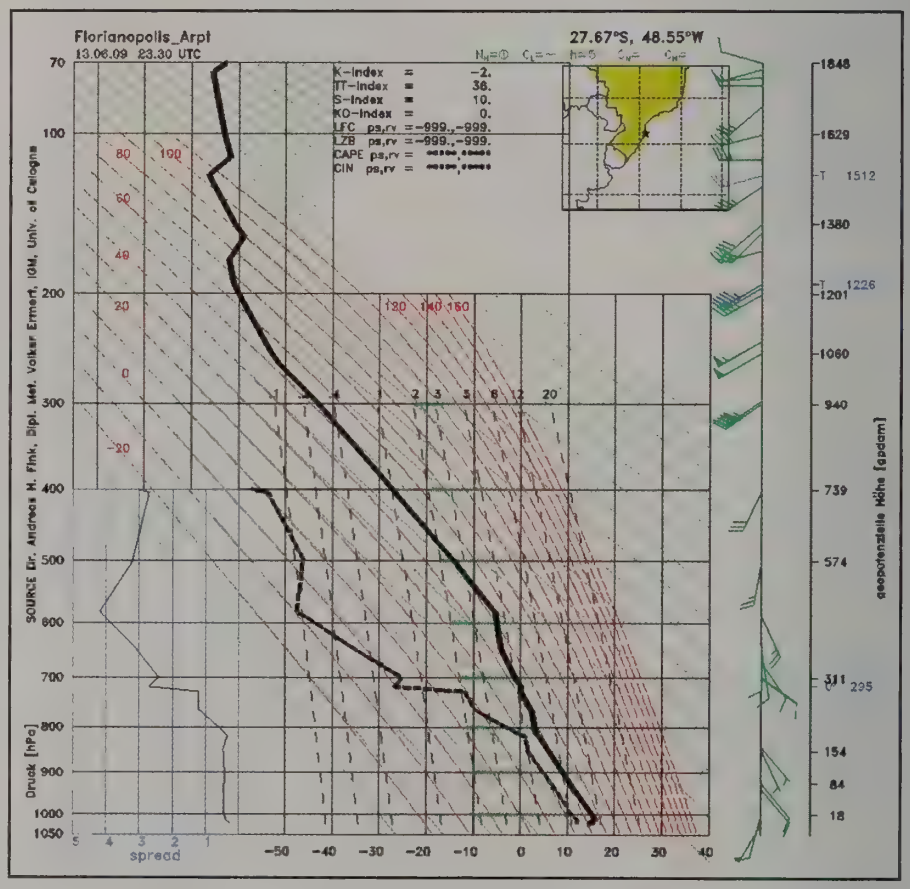

Figure 1(A). No inversion. Note the steady temperature (solid line) and humidity (dashed line) declines.

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In this article we will focus on subsidence ducts. These subsidence ducts are a primary cause for extremely long-range temperature inversions across open ocean paths. We will explore these ducts, the mechanisms that cause them, and where they appear. We will also investigate why some paths have not been worked yet, and offer a few observations and suggestions on potential strategies to work these paths.

Propagation Mechanism

The primary propagation mechanism for trans-oceanic ducting is the *subsidence* temperature inversion. Large areas of subsiding, or falling, air cause subsidence inversions. The largest subsiding air masses are associated with stable high-pressure systems that form over the oceans. As sunlight strikes the Earth, it heats the air, causing it to rise. The air over the equator, with the most direct sunlight and therefore the highest energy transfer, heats up the most. This rising air eventually spreads out away from the equator, heading north and south. The rising air creates a surface low-pressure system, which is replaced by air flowing in from more temperate areas farther from the equator with higher pressure air. The air rising over the equator, flowing away towards the pole, sinking over temperate regions, and flowing back to the equator is called a *Hadley Cell*. The falling air creates a stable high-pressure system that can exist for many months during the summer.

As the air falls on the downward cycle of the Hadley Cell, it is compressed, raising its temperature. The rising temperature causes the relative humidity in the sinking air mass to drop significantly. Under normal non-inversion conditions, rising air cools and becomes wetter. When the warm, dry sinking air meets the moist, rising air that has been heated locally, a temperature inversion is created.

Fortunately, there are many weather sources available on the web to help us find these stable high-pressure systems where ducting is more likely to form. Probably the most useful and quickest way to see if conditions are possible is by checking the Hepburn Tropospheric Ducting Forecasts at <http://www.dxinfocentre.com/tropo.html>. I have found them to be reasonably accurate for a broad-strokes prediction. The map illustrated here (figure 2) was from the spring of 2008, showing very good conditions across the southern part of the

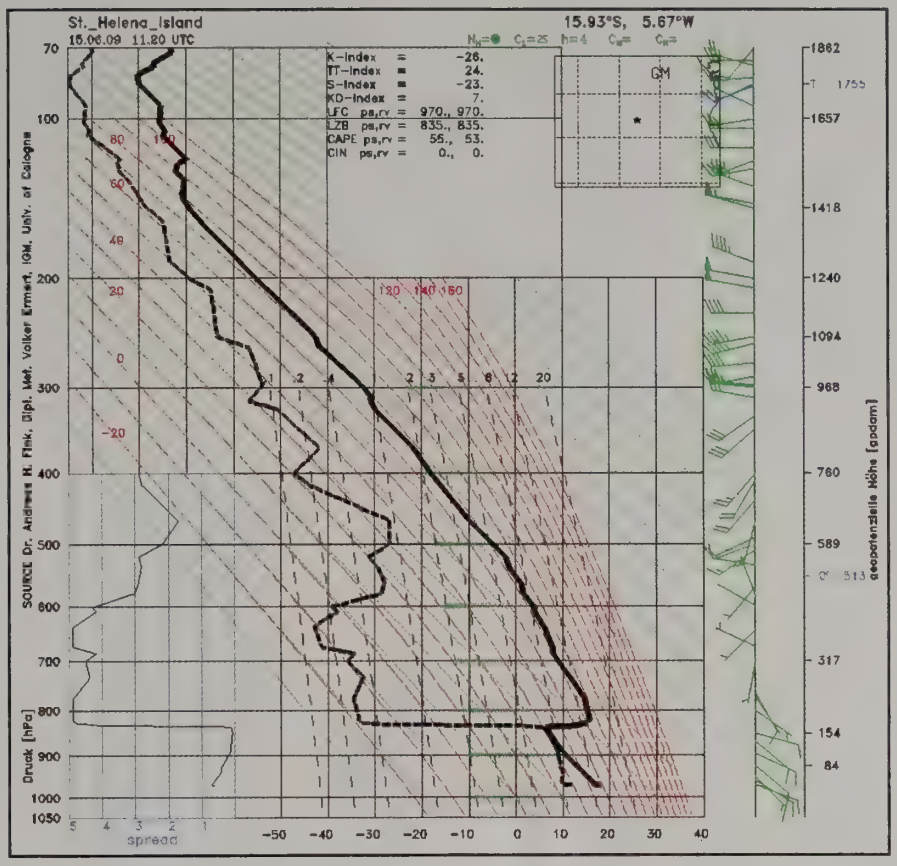

Figure 1(B). A strong temperature inversion. Note the sharp temperature rise and humidity drop at the inversion layer.

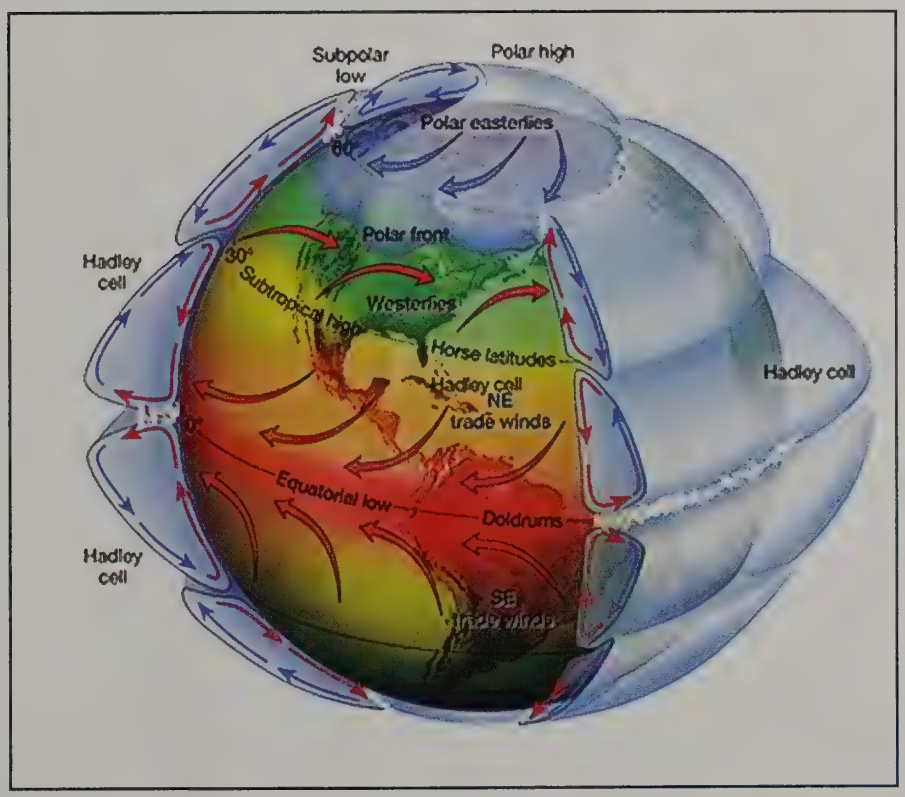

Figure 2. Hadley Cell circulation.

North Atlantic Ocean. As the high pressure moves northward with the summer, so do the conditions. Tropical storm development later in the summer tends to break up any ducts in the southern extremes.

Isobaric weather maps show us just where the high-pressure systems are located and how strong they are. The Oceanweather web page at <www.oceanweather.com/data> provides maps of much of the world. The Marine Observations in each area will show the actual isobaric weather chart.

The Sea Surface Temperature charts, also available on the Oceanweather page, may also be helpful. There is some evidence; published in the "Atmospheric Refraction" article listed in the references section is a chart that correlates sea surface temperature to duct height. This is important, as one can read in the article by VK3KAQ about "Facts and Myths about Tropospheric Ducting" on the DF5AI web page. Essentially, the higher a duct is above the VHF station, the steeper the entry angle and the higher the coupling loss will be into the duct. While the sea surface temperature will have some effect on the height of a subsidence duct, it has a very strong influence on evaporation ducts.

Another helpful tool to zoom in on conditions is radiosonde data. Radiosondes are launched daily by many weather stations around the world. As they ascend, they report back on several atmospheric conditions, including temperature and humidity. Radiosonde data can be easily obtained from <http://www.uni-koeln.de/math-nat-fak/geomet/meteo/winfos/radiosonden/index_erde.html>.

The radiosonde data example in figure 3 shows a very strong inversion over St. Helena Island in the South Atlantic Ocean. This region has exceptionally good and stable ducts that can be present on nearly half the days of the local summer. The solid line represents the temperature, and the dashed line is the relative humidity. Note that at the 750-mb level (about 8000 ft. msl) the air temperature stops decreasing and rises about 8 degrees F. At the same elevation, there is a very sharp drop in humidity. This is evidence of a very strong duct.

There are a few points are worth noting from the diagram:

First, the greater the temperature increase and the relative humidity decrease, the stronger the inversion will be.

Second, the thicker the inversion from top to bottom, the lower the frequency the inversion typically will support for ducting propagation.

Third, the humidity drop has a greater influence on good ducting conditions forming than the temperature increase.

Finally, if a line drawn vertically downward from the right-most point of the inversion reaches all the way to the ground, the duct is referred to as a *surface* duct. If, on the other hand, the vertical line drawn down intersects the rising temperature line above the Earth's surface, the duct is referred to an *elevated* duct.

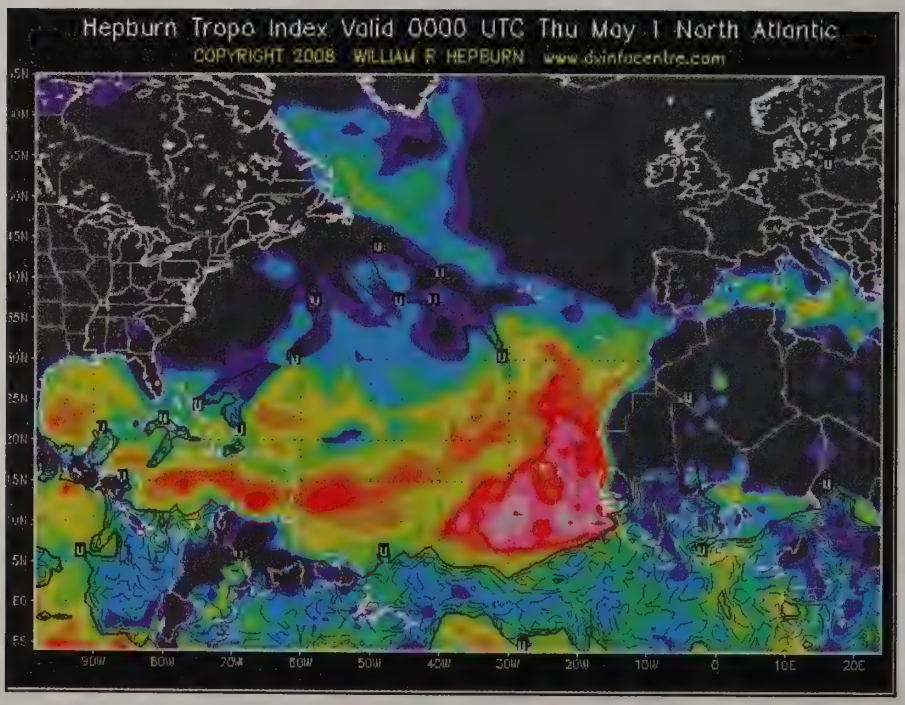

Figure 3. A Hepburn map showing strong potential ducting across the North Atlantic.

Established and Potential Trans-Oceanic VHF Ducts

Tropospheric ducting spanning long trans-oceanic paths has not been fully explored. Several regions are already well proven. Some of these have been worked for more than five decades, while others have been *discovered* more recently. These established paths are shown in figure 4 by dark lines.

Other trans-oceanic ducts have long been suspected. Occasional reports of DX reception over very long oceanic paths have been noted over several paths. The potential paths are illustrated in figure 4 by the lighter lines. Probably the main reason these paths have not yet been worked is the lack of operators interested in and equipped to work these paths in the optimum locations. This list is by no means definitive either and other paths very likely exist (figure 5).

The South Atlantic ducts have been proven to exist. N7BHC directed ZD7 monitoring tests listening for FM broadcast stations in Africa and Brazil. John Turner, an SWL on St. Helena, reported hearing numerous FM stations from South Africa, Namibia, and Angola in early 2008 on a car radio. In late 2008, John and ZD7X heard many African and Brazilian FM stations, and 156-MHz marine radio from Namibia. ZD8I reports many instances of receiving Cape Town Harbor radio on 156 MHz, and ZD8S reports that it is common to listen to Brazilian FM stations using indoor portable radios. On one occasion in late 2008, FM broadcast-band listeners on St. Helena complained that they could not identify an Angolan station due to interference from a Brazilian station on the same frequency!

One more noteworthy point is that all the paths already worked appear to be on the equatorial side of the high-pressure systems. Very few, or none, have been reported traveling over the middle of the high-pressure system, or on the polar side for east-west paths.

Strategies for Finding Trans-Oceanic Ducts

Quite often, band openings go unnoticed because of a lack of activity of both

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transmitting and receiving stations. One approach to catching openings is to watch weather data and propagation maps, and set up schedules with stations across the oceans when a band opening looks likely. This requires a lot of vigilance, and operators need to be available at any time and stay close to their radios. Further complicating matters is that many potential paths do not have active VHF stations at one or both ends.

DXpeditions to likely locations are another approach to duct hunting from locations with no regular activity. A series of expeditions took place in January 2009 to focus on the South Atlantic path between Namibia and Brazil. N7BHC operated from Luderitz Bay in Namibia, and several Brazilian operators operated from their home QTHs or undertook expeditions to the northeast coast of Brazil. ZD8I also operated from Ascension Island. While the path was not successfully worked in January 2009, the conditions are now proven to exist. It is just a matter of time before concerted and long-term efforts by hams on both continents will result in success.

Beacon Projects

Beacons are useful propagation indicators. They transmit a signal at a stable frequency, power, and beam pattern. This allows distant receiving stations to have a signal to monitor for possible band openings.

Beacons are especially useful in locations that don't have a lot of regular activity on the band of interest. In many instances, DX operators have limited resources to invest in equipment. HF operation promises many more QSOs than VHF, so HF stations and operations are much more common. Most have little or no interest in, or equipment available, for VHF. A beacon project could build and deploy beacons at key locations for the purpose of studying extreme-range trans-oceanic ducting propagation. These beacons would be optimized for studying long-range trans-oceanic ducting. The initial focus would be on the North and South Atlantic oceans (figure 6).

Beacons designed specifically to study long-range VHF ducts should have a high ERP (Effective Radiated Power). This requires a higher transmit power than usual for beacons, and a moderately high-gain antenna. Transmit power of 100 watts is quite easily realized. The antenna selection can be more complex, as one has to consider the arc of the stations

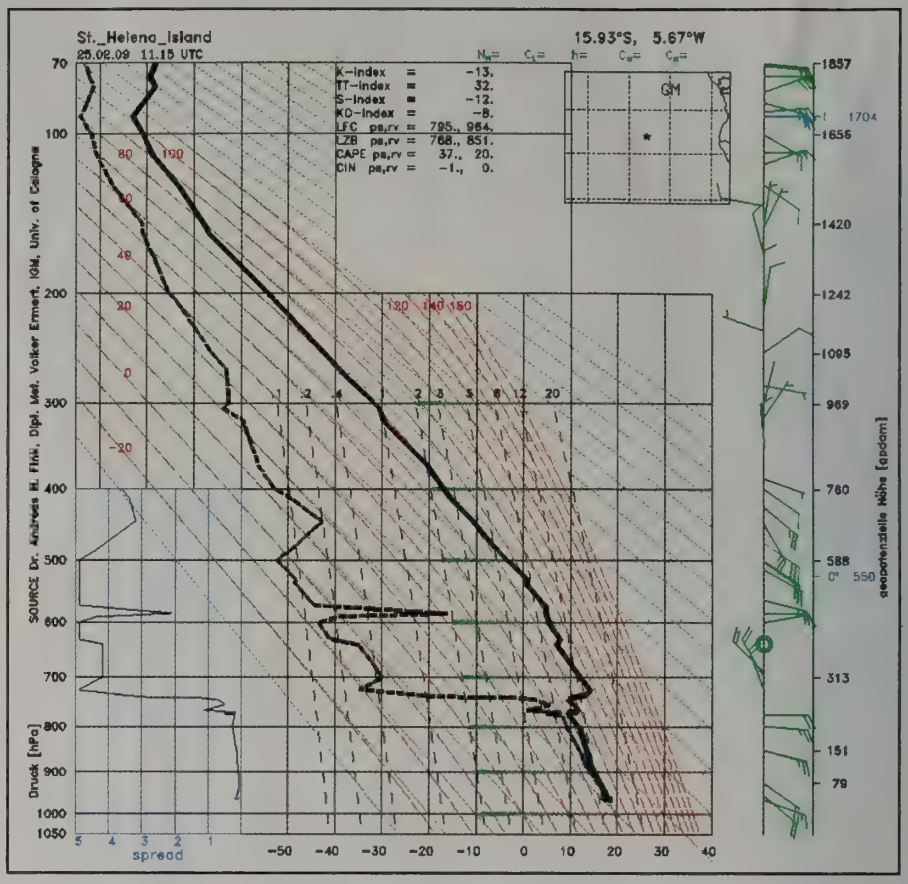

Figure 4. This radiosonde data from St. Helena Island in the South Atlantic shows a very strong elevated duct.

toward which the beacon is transmitting. A point-to-point system, such as Virginia to Portugal, could use a single long Yagi. However, a point-to-multipoint system such as Virginia to an arc stretching from the UK to North Africa requires a much wider beamwidth. This is easily accomplished with a vertical stack of shorter Yagis. It would be very disappointing to have an opening go unworked because the beam was pointed at Europe while the band was open to North Africa. Beacons on mid-ocean islands have more complex antenna requirements if they are to radiate signals in multiple directions and still have high ERP. It may, in fact, be easier to run multiple beacons or a switched antenna network.

It would be very desirable to have a VHF or DX association be the overall coordinating agency for the beacon network. So far, a key collaborator on a North Atlantic beacon project is Paul Trotter AA4ZZ, from the Charlotte, North Carolina, area. The biggest challenge to deploying a tropo-duct, long-range VHF beacon network, though, is not a technical one. Finding a local amateur radio operator who is interested in installing and maintaining a beacon has been the biggest hurdle, even when the equipment is offered free of charge.

The **Simple Multifunction Beacon** concept designed by Dave, N7BHC, goes one step further (figure 7). It is based on multimode radios with an amplifier and keyer. The system operates as a beacon most of the time. When a band opening is reported, the local operator can turn off the beacon and use the same equipment to work DX. The Simple Multifunction Beacon design will be addressed in a future article covering assembly and operation.

The first N7BHC beacon was deployed in FM15PA in the summer of 2008. It runs a Kenwood TR-751A radio with a 160-watt amplifier turned down to 100 watts output. After feedline loss, approximately 60 watts is radiated from a 16-element KLM Yagi beamed towards Gibraltar. In August 2008, bursts from that beacon were copied by CT1HZE in southern Portugal.

An **Advanced Capability Beacon** project is also under way. This is a much more complex beacon that uses a Windows® computer under remote con-

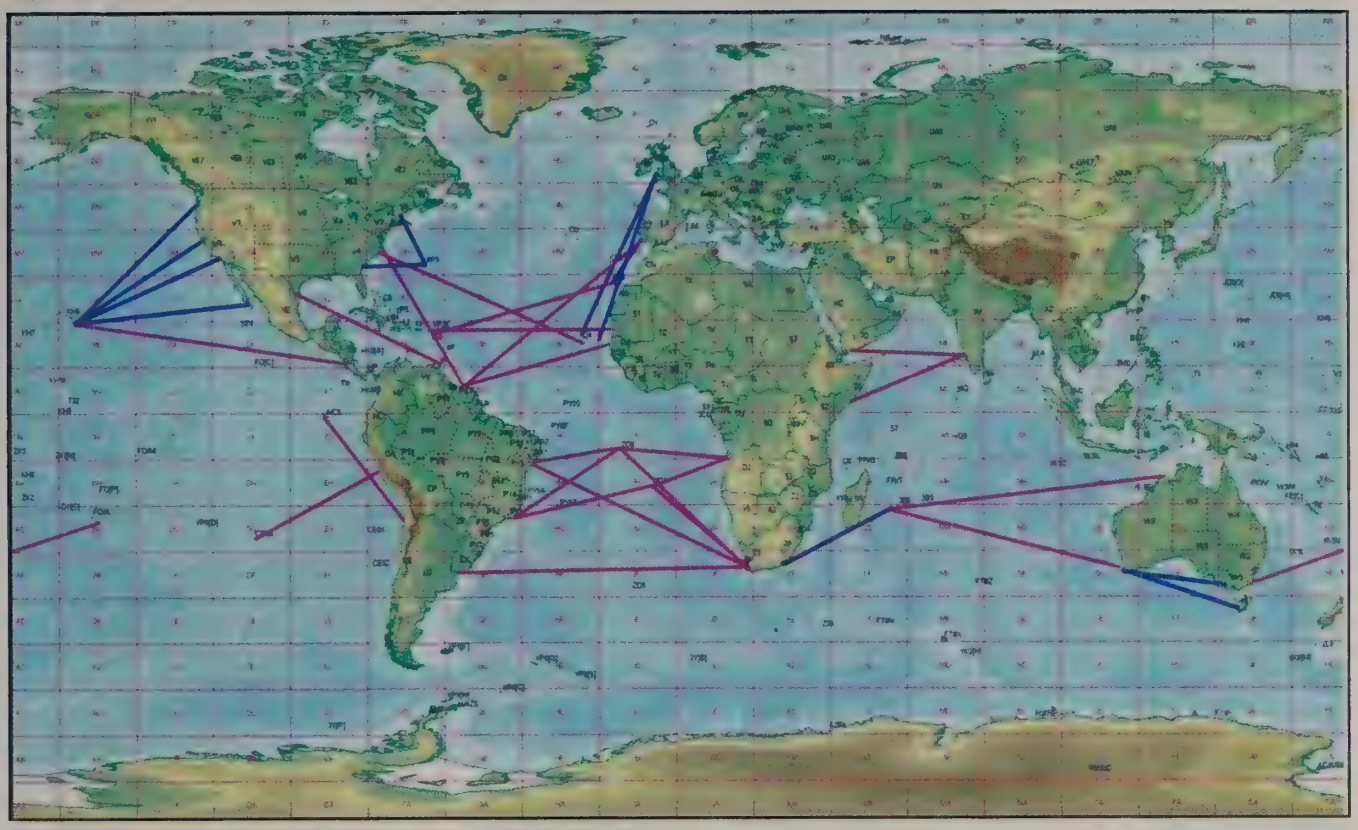

Figure 5. Worked (blue) and possible (purple) VHF tropo duct paths.

trol to operate the beacon. The beacon can operate autonomously, but the remote-access capability allows for the beacon parameters to be changed remotely, new modes to be uploaded, and remote telemetry to be monitored. In addition, the receive audio can be monitored between transmissions, and the system can even be used as a remote base should a band opening occur. Additional information and the design criteria for the Advanced Capability Beacon can be viewed on the N7BHC web page.

Additional beacon topologies await further evaluation. One interesting approach would be to locate the radio remotely, but have the controlling computer at the local shack. The interconnection between the two would rely on RoIP (Radio over Internet Protocol) interfaces such as the JPS NXU-2A.

Non-Amateur Radio Beacons: In addition to building amateur radio frequency beacons, there are many VHF and UHF signals already on the air that do excellent service as beacons. As their frequencies are close to the 144-MHz and 432-MHz bands, they serve as good propagation indicators for those frequency ranges.

FM

FM voice repeaters and stations on 144 MHz and 440 MHz should be part of the serious duct hunter's weapons as well. While CW, SSB, and digital modes offer the best weak-signal performance, the FM repeater and simplex operators win out in sheer number of stations active. Quite often, band openings are discovered by hearing distant FM repeaters first. A dedicated FM system with stacked Yagis makes an excellent system for finding DX. You can always ask the distant operator to switch to FM simplex or weak-signal modes. Also, sometimes those stations may have an all-mode radio hooked to a good vertically polarized antenna system for working distant repeaters, and the operator has never explored the weak-signal mode aspect of his station.

FM and television broadcast stations also make excellent beacons. They are plentiful and widespread. Several new tropospheric ducting paths were first identified and confirmed by listening for FM radio stations, including the paths from St. Helena Island to southern Africa, and Ascension Island to Brazil. Most FM stations stay on the air around the clock and do not shut down late at night and the early morning hours when transoceanic ducting is at its best.

A log-periodic antenna is essential to cover the whole band. Quite a few low-power FM stations transmit with vertical polarization, so an antenna that can be rotated in polarity, or two separate antennas for horizontal and vertical polarization, is required. If two antennas cannot be used, then a single Yagi at a 45-degree angle may be a good compromise as it is equally down –3 dB from both horizontal and vertical polarities.

A good receiver is also essential, requiring excellent sensitivity and selectivity. High-performance wideband receivers such as the ICOM R7000, R7100, R-8500, and R-9000 all are excellent choices. Professional-grade receivers such as the Rohde & Schwarz ESM-500A, ICOM R-9500, and Ten-Tec RX-400 are very good performers. Another surprisingly low-cost receiver option with amazing performance is one of the Sony HD radio series. The XDR-S10Hdip is a full receiver, while the XDRF1HD is a tuner only without an amplifier. A good source of information on FM stations is the <www.fmscan. com> web page.

Analog (non-digital) TV stations are being replaced by lower power digital transmissions in many countries. VHF high-band stations in the 174–216 MHz range are good indicators of 144-

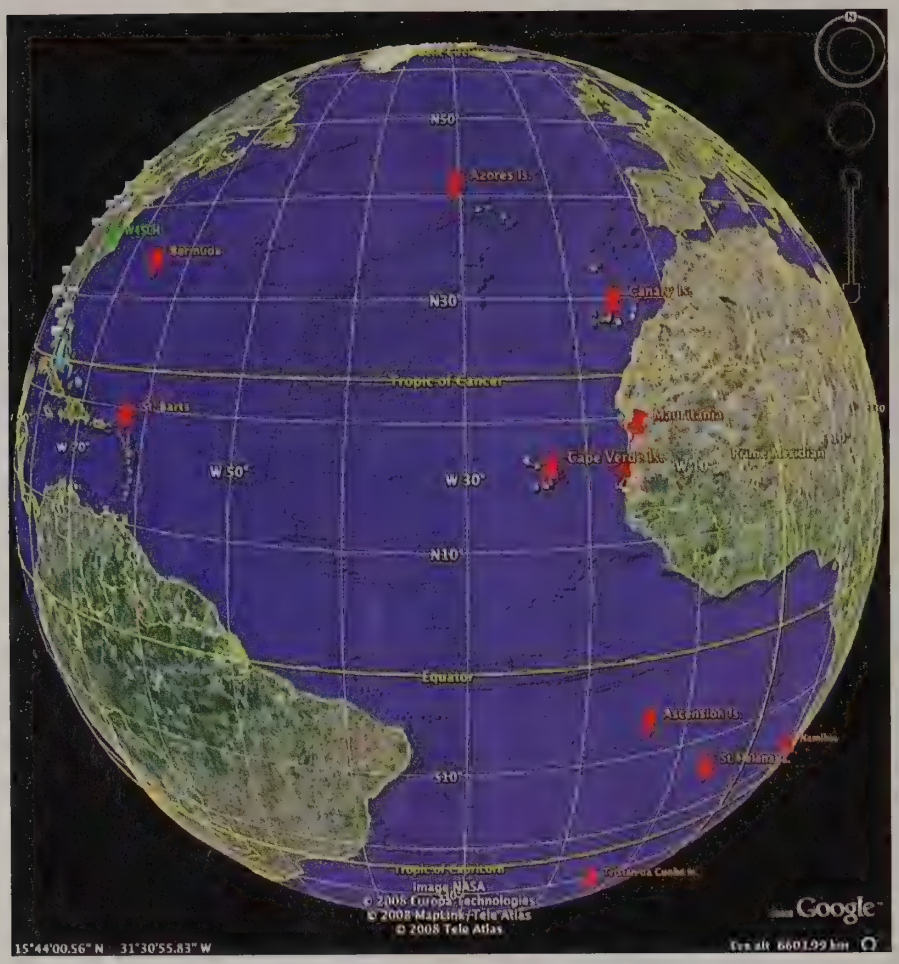

Figure 6. Potential sites for a North Atlantic VHF beacon network.

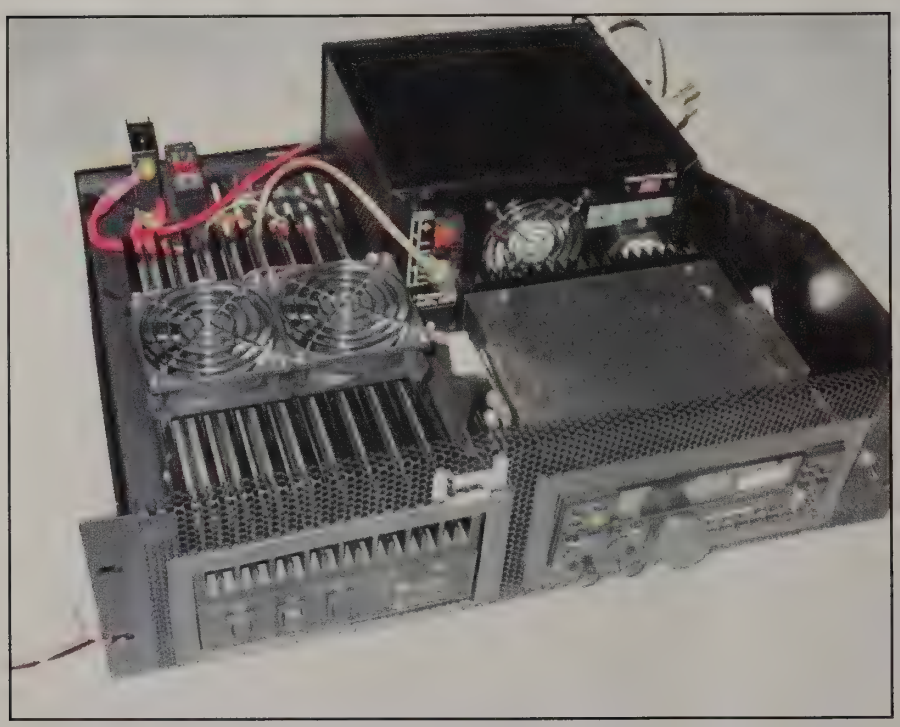

Figure 7. The N7BHC Simple Multifunction Beacon/station.

MHz propagation, while UHF stations are excellent indicators of 430-MHz openings. Many TV stations go off the air late at night. They often run higher power than FM stations. On an analog TV signal, the video carrier is the strongest component of the TV signal, but is not easily identified. The only practical way to identify video carriers is by knowing their frequency *very* precisely. However, they are useful for showing that the band is at least open in a general direction.

Wideband receivers such as those used for monitoring FM stations are good choices for listening to TV stations. The analog TV signal has to be very strong before a picture good enough to serve as identification is visible, but the FM audio channels can be well received considerably before the video comes in well.

With TV stations in many countries switching to lower power digital format, video carriers are not as strong. A plus factor is that the digital data stream includes the station call letters, making station identification much easier.

As with FM broadcast stations, a good log-periodic antenna is the best all-around TV DX antenna. Several very good commercial products are available that cover both the FM and TV bands, plus public safety and utility bands between the broadcast station assignments.

Aviation Band Stations

Aviation band signals from 108–136 MHz have been used for many years to indicate the presence of VHF ducts. Some years before amateurs first worked the duct between California and Hawaii, pilots taking off from San Francisco would report contacts with the control tower in Honolulu as they climbed above the Golden Gate Bridge. As they climbed higher, above the duct trapping layer, the communication was lost until the aircraft came within visible sight of the station in Hawaii. Airport stations are also on well-publicized lists, and the air traffic controllers usually identify on every transmission.

Marine Band Stations

Marine band stations in the 156–163 MHz range are useful to monitor for band openings. The duct from Ascension Island to Cape Town was first identified by the reception of Cape Town Harbor Radio on Ascension. However, voice transmissions can be fairly sporadic, and ships usually only communicate with the

Figure 8. An AIS display showing ship positions. We're not concerned with the specific ship data as much as the fact that it was received by a given station, indicating an opening.

port facilities when they are fairly close to the harbor. With commercial vessels ranging the full extent of the oceans, it would be very helpful if they were transmitting frequently as they crossed the oceans, our area of interest. Essentially, that would amount to a beacon network with thousands of stations spread across the oceans. Fortunately, that beacon network is exactly what is available!

The Maritime AIS

The Maritime AIS (Automatic Identification System) is a system used by ships for identifying and locating vessels (figures 8 and 9). AIS provides identification, position, course, and speed, similar to a maritime equivalent of APRS. This information can be displayed on a PC using simple receivers and PC software, or dedicated receivers with internal modems can also be used. While intended for exchanging data directly between vessels, and between vessels and shore-based vessel tracking services, it is also monitored by many private individuals operating on two channels around 162 MHz. Several of the software packages also link the data onto internet position servers.

The AIS transmissions use low-power 9600-baud data and omni-directional antennas. While these low ERP signals do not meet the ideal of a high ERP beacon, they are pervasive and plentiful across the oceans. They are easily monitored using specialized receivers or 9600-baud capable 2-meter amateur radio sets. This material is to be covered extensively in a future article. The reader is encouraged to review the author's web page referenced at the end of this article as a starting point for more information.

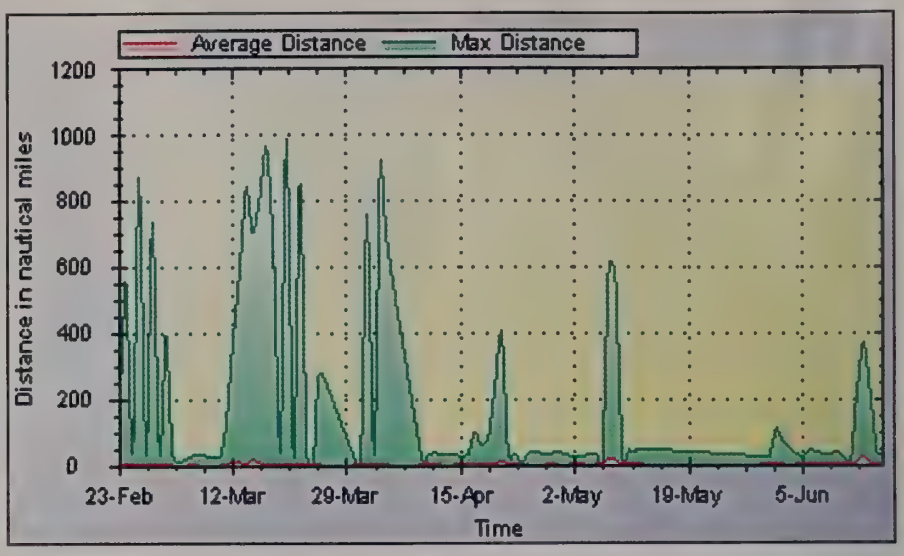

Figure 9. Historical data from an AIS station showing the standard range of 50 miles and the tropo ducting ranges of up to 1000 miles.

Phil, FR5DN, built a system in just a few hours over one weekend. Phil's station typically receives ship signals from 150 miles away and quite often reports ships more than 500 miles towards South Africa. His real-time data is added to the hundreds of other sites already posting their data to the internet AIS pages. The web pages also provide statistical data on the last several weeks of stations heard, such as average and peak ranges. At least one university has an active research project using AIS to study and indicate trans-oceanic ducting.

Public Service Band Stations

Public service band signals are not as universally helpful as the other services listed above. As with television video carriers, they typically are more useful for showing the presence of an opening rather than the specific source. Most operators do not identify with a location. Many public service radio systems are switching to digital radio, further complicating identification.

Summary

The potential for VHF ducting over new trans-oceanic paths is very high. The main limitations so far have been lack of equipment and dedicated, patient operators. Paths will be worked as more people take up the challenge. The key discipline of study to understand this propagation mode is meteorology rather than ionization.

References: Additional Information on Ducting

There are several good articles on the internet on this tropospheric ducting. The reader is encouraged to begin with a review of the following articles on the web.

- Temperature inversion basics: <http://www.mike-willis.com/Tutorial/PF6.htm> and <http://en.wikipedia.org/wiki/Temperature_inversion>.
- DF5AI has several excellent pages on tropospheric trans-oceanic ducting at: <http://www.df5ai.net/Material/articles3.html#ArticlesDucting>.
- Australian National VHF DX Group: <http://www.users.bigpond.com/anvdg/propagation.htm>.
- "Atmospheric Refraction: How Electromagnetic Waves Bend in the Atmosphere and Why it Matters" provides a good synopsis of inversions. Go to: <http://www.google.com/url?sa=U&start=1&q=http://www.weather.nps.navy.mil/%7Epsguest/EMEO_online/module4/Atmospheric_Refraction_of_EM_Waves.doc&ei=48FNSbO6KYyc8wT9q9SiDw&usg=AFQjCNF4rUNqYYkONQ0OGk2CCCM7n-MTfQ>.
- "Thermodynamic Structures of Subsidence Inversions" is a good white paper on the climatology of subsidence inversions at: <http://handle.dtic.mil/100.2/ADA265406>
- The N7BHC web page on tropospheric ducting: <http://sites.google.com/site/n7bhcvhf/trans-oceantic-ducting>.
- AIS Maritime Beacon information: <http://sites.google.com/site/n7bhcvhf/trans-oceanic-ducting/beacon-project/non-amateur-beacons/marine-band-beacons>

Amateur Radio and the Cosmos

Part 1 – From Our Meager Beginnings

Threaded throughout our hobby's history is a curious connection between amateur radio and the cosmos. Here in Part 1 of this article WA2VVA explores this connection while reporting on the history of some of the early players.

By Mark Morrison,* WA2VVA

As a young boy growing up near the Bell Telephone Laboratories in the 1960s, it was hard to appreciate what went on behind those brick walls. Situated on the first ridge of the Watchung Mountains, with a nature preserve to the rear and an expansive manicured lawn to the front, the sprawling campus of the Murray Hill, New Jersey facility and its otherwise unassuming tan buildings provided little clue as to what went on inside. Although history would reveal that "Bell Labs" was behind the Telstar satellite, the first transistor, the touch tone, video and cellular telephones, the laser, fiber optics, and software developments such as the Unix operating system and the C programming language, such things didn't achieve public recognition until years later.

Even the people who worked at Bell Labs and lived in the surrounding neighborhoods didn't talk much about what went on there. It was a curious thing that your next-door neighbor could be a policeman, a carnation grower, or a world-famous radio astronomer. Indeed, George C. Southworth, inventor of the waveguide and one of the first persons to detect radio emissions from the Sun, lived just around the corner, something I only just came to realize. Still, Bell Labs did invest in public relations, as my classmates and I well remember.

Our first glimpse at Bell Labs technology was at the local elementary school. In a gesture inconceivable by today's standards, the father of one of my fourth-grade classmates, P. K. Tien, arranged for a public laser demonstration in the halls

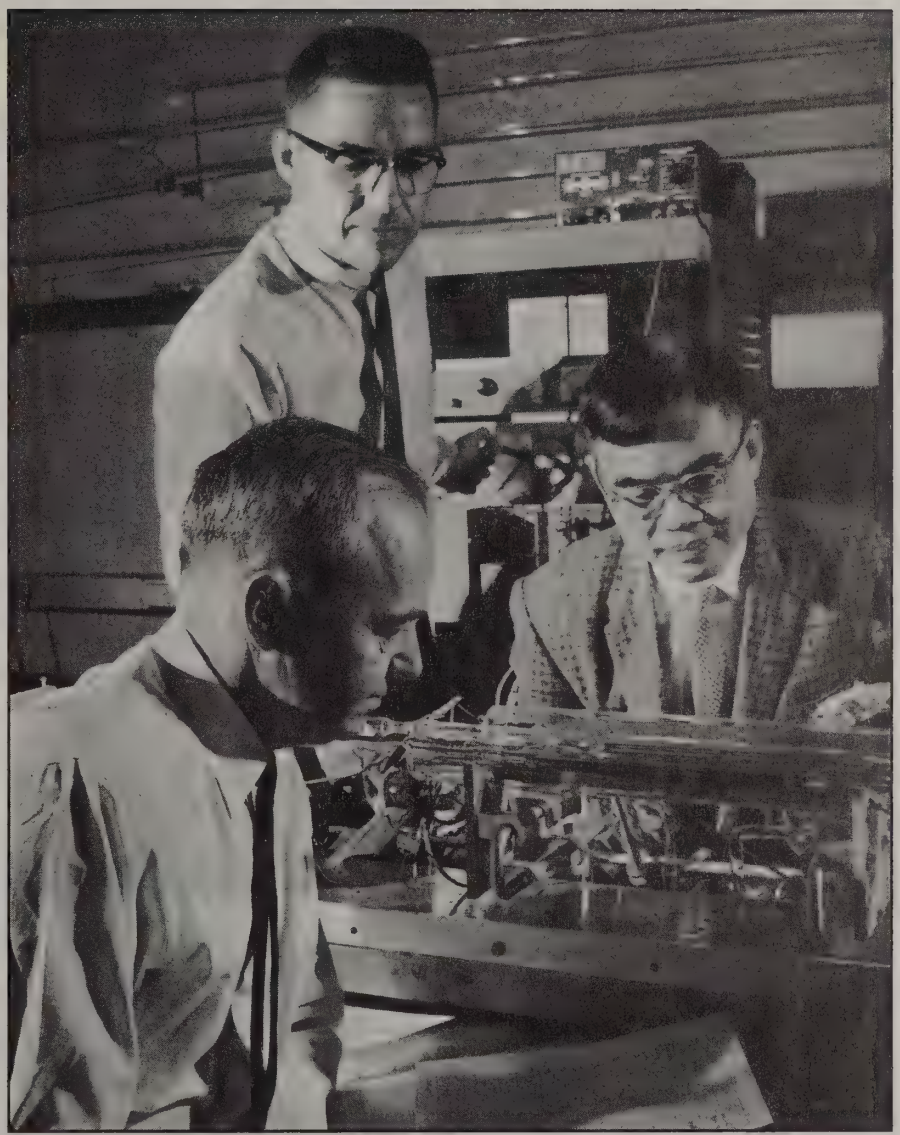

Photo 1. Shown are Bell Labs scientists P. K. Tien (right), D. McNair (left), and H. L. Hodges (center). They are examining their new triode lasers (there are two shown) which allowed laser light intensity to be modulated using an internal grid. (Source: From Semaphore to Satellite, *published by the ITU in 1965)*

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e-mail: <mark1home@aol.com>

of the local elementary school. I still remember how that mysterious light projected down the longest hallway of the school, revealing nothing more than a small dot at the other end. Photo 1 shows P.K. Tien and his colleagues working with a laser in the 1960s.

Although much of the work at Bell Labs would eventually receive widespread public recognition, such as the first television broadcasts using satellites, much of the technology and achievements were appreciated more in technical circles than by the general public. Nowhere is that more evident than in the world of radio astronomy. Starting in 1931, it was a Bell Labs radio engineer by the name of Karl Jansky who first discovered radio waves of extraterrestrial origin. Assigned to investigate sources of noise affecting overseas phone communications, Jansky directed a carpenter in the construction of a rotating wooden frame supporting an array of metal tubes and glass insulators. Photo 2 shows a replica of the Jansky antenna that is on display at the National Radio Astronomy Observatory in Green Bank, West Virginia.

Jansky's antenna was of the Bruce design, the namesake of yet another Bell Labs employee, Edmund Bruce, who patented this design as illustrated in photo 3.

Jansky's version used wheels from a Model T to rotate the antenna on a brick track, thus allowing him to isolate the direction of various noise sources. At the suggestion of George C. Southworth, Jansky plotted out his data, making the daily patterns of static more clearly visible. As a result, Karl came to recognize how one pattern peaked every 23 hours 56 minutes, or 4 minutes earlier each day. This corresponds to the movement of the Earth with respect to the stars, not the Sun, a clear indication that Jansky's static originated beyond our solar system. Jansky later concluded that this noise was coming from the Milky Way galaxy itself.

Jansky's discovery received little attention at first, possibly because it came during the Great Depression when few astronomers had the resources to do serious follow-up work. More likely is that it conflicted with the science of the day. At that time it was generally believed that hot objects such as the Sun and stars radiate most of their energy in the visible part of spectrum, and not at radio wavelengths. Whatever the reason, further thought on the subject would be left to three amateur radio operators: Hiram Percy Maxim, W1AW, Grote Reber, W9GFZ, and John Kraus, W8JK.

Hiram Percy Maxim, who co-founded the ARRL in 1914, published a book on the possibilities of extraterrestrial communications called *Life's Place in the Cosmos* in 1932. *QST* magazine, the official publication of the ARRL, had this to say about the book in its May 1933 issue: "It provides food for intriguing conjecture on the subject of interstellar communications—a field so far quite as virgin as the field that Marco Polo operated in 600 years ago. It leads us to the thrilling thought that, from our meager beginnings, some future generation of ama-

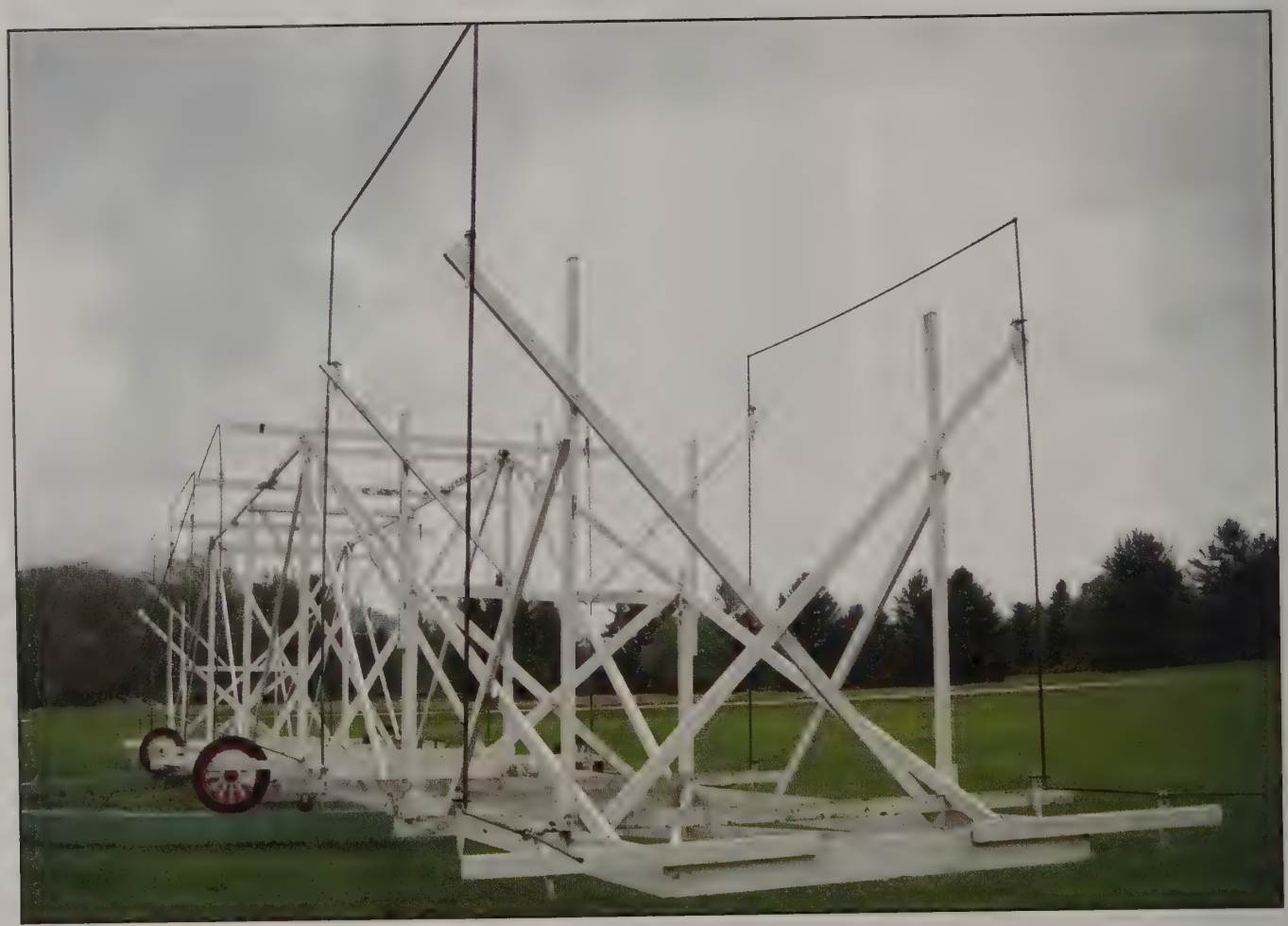

Photo 2. A replica of the Jansky antenna that is on display at the National Radio Astronomy Observatory in Green Bank, West Virginia.

teurs may figure their DX in megamiles."

It's not clear that Maxim was aware of Jansky's work, but the idea of communicating with extraterrestrial civilizations wasn't exactly new either. In the late 1800s some were speculating that light waves might be used to communicate with life on nearby planets. Later, the possibilities of communicating by radio waves also became a popular notion. In 1909 *The New York Times* published a letter to the editor from inventor Nikola Tesla entitled "How To Signal Mars" in which he extolled the virtues of radio waves over light waves. Tesla claimed, "It is evident, then, that in my experiments of 1899 and 1900, I have already produced disturbances on Mars incomparably more powerful than could be attained by any light reflectors, however large." That Tesla would choose Mars is to be understood by the popular notion that if life existed elsewhere in the solar system, it would most likely be found on the red planet. This view was popularized by astronomer Percival Lowell, who had speculated the canal-like features he observed on Mars were an indication of intelligent life there. Maxim may well have been influenced by such thinking, as both Mars and radio were favorite subjects of his.

Grote Reber, who lived in Wheaton, Illinois, was so interested in Jansky's work that he applied to Bell Labs in hopes of actually working with him. When Reber learned that Jansky had been assigned to other work, he looked for other ways to satisfy his appetite for the subject. His first step was to improve the UHF (>56 Mc) receivers of the day. Throughout the 1930s Reber's designs were published in a West Coast magazine popular with hams and shortwave listeners known simply as *Radio*. The January 1938 issue of *Radio* shows a Reber designed receiver for 1 1/4 meters using concentric line couplers instead of traditional lumped elements.

In the 1930s vacuum tubes weren't commonly available for use above 56 Mc, so Reber had to build or modify everything himself. Complicating matters was not knowing exactly what frequencies to use. So it was that Reber started his quest to build receivers that worked not only at uncommon frequencies, but also without any knowledge whatsoever if anything would be heard at those frequencies. When Reber built his third receiver in 1942, one designed to operate at 160 MHz, his long hours of work were finally rewarded. Photo 4 shows the first successful receiver used by Reber in his early radio astronomy work. Note the concentric-line receiver placed upon the cabinet in the right of the picture.

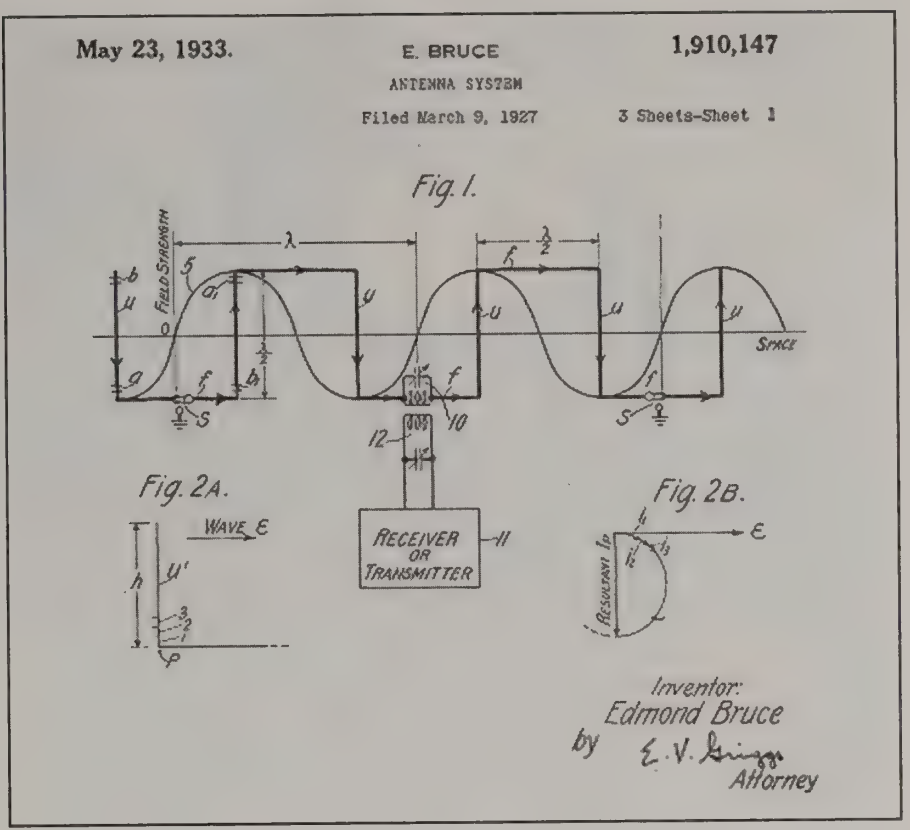

Photo 3. Jansky's antenna was of the Bruce design, the namesake of another Bell Labs employee, Edmund Bruce, who patented this design as illustrated here.

Also unusual for the time was Reber's choice of antenna. During the 1930s the most popular antenna was arguably the flat top beam developed by Kraus, W8JK, and, coincidentally, discussed more than once in that same issue of *Radio*. Although directional beams had their draw, Reber decided on the parabolic dish for his studies of extraterrestrial radio sources. How he made that decision is not clear. Perhaps he was influenced by advances in optical astronomy that were made possible by large parabolic mirrors. Not surprisingly, Reber's parabolic dish is now considered the prototype of the modern radio astronomy dish. Reber made this dish himself and mounted it on a rigid frame that allowed the angle of the dish above the horizon to be changed but not rotated. Photo 5 shows Reber's dish antenna now on display at the entrance to the National Radio Astronomy Observatory (NRAO) in Greenbank, West Virginia. The turntable was added years later.

Reber used a pen recorder to capture signals of extraterrestrial origin as the Earth's own rotation directed the dish toward different parts of the sky, much as Karl Jansky had done years earlier. However, by changing the elevation of the dish each day, Reber could piece together a mosaic of the entire sky. From his backyard location Reber created the first radio maps of the heavens and published his work in some important journals of the time.

In 1945 George Southworth made his own mark in radio astronomy when he detected radio emissions from the Sun, following similar work by J. S. Hey, and giving proof to the predictions of Oliver Heaviside, who in the late 1800s had predicted that such emissions existed. By this time Southworth had established something of a regular correspondence with Reber and shared many ideas on solar emissions with him. In one letter dated 1945, Southworth laments to Reber about not being able to do more solar observing, mainly due to the war effort, and he encouraged Reber to continue doing whatever observing he could (see photo 6). This is perfect example of the

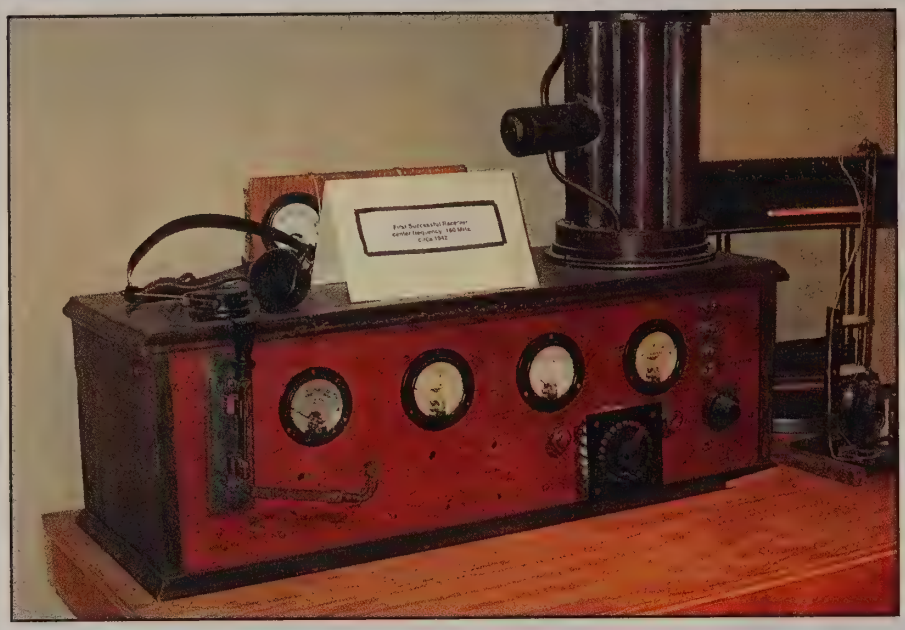

Photo 4. The first successful receiver used by Reber in his early radio astronomy work. Note the concentric-line receiver placed upon the cabinet on the right.

role that amateur radio can play when scientists are otherwise engaged.

In 1945 Reber's work received some important recognition when one of the world's great (optical) astronomers was visiting Chicago, not far from Wheaton. Years earlier, Van de Hulst had speculated that neutral hydrogen might be a source of extraterrestrial radio energy at 1420 MHz. Van de Hulst spoke with Reber about building a receiver for this frequency, which Reber apparently did contemplate, but due to other work was not able to follow through on.

Another amateur hampered by the war effort was Jack DeWitt, N4CBC (his call when he passed away on January 25, 1999). During the war DeWitt was stationed at Evans Signal Laboratory in Wall, New Jersey. This was the secret radar lab of the U.S. Signal Corps and also a former Marconi receiving site. Before the war DeWitt had pondered moonbounce, and when the war ended he received permission from his superiors to attempt such a feat. On January 10, 1946 DeWitt and his colleagues became the first in history to bounce a signal off the moon and detect it back on Earth.

In 1951 two Harvard scientists, Harold Ewen and Edward Purcell, took it upon themselves to design and build a horn antenna and receiving apparatus for the express purpose of detecting the hydrogen emissions Van de Hulst had speculated about years earlier. On March 25, 1951 they succeeded in detecting these emissions, the very first spectral line ever observed in radio astronomy. Soon after, scientists theorized that if hydrogen was moving with respect to an Earth-bound observer, one might determine its speed and relative direction using Doppler techniques already familiar to terrestrial radar operators. Using such methods, astronomers discovered that our own Milky Way galaxy has a spiral shape, something impossible to discern using optical telescopes.

In 1953 DeWitt's moonbounce work would be continued when amateurs Bill Smith, W3GKP, and Ross Bateman, W4AO, succeeded in hearing their own moon echoes using a rhombic antenna in Virginia. Two years later, Jim Kmosko, W2NLY, would build a huge array of long Yagis in New Jersey and use it for a series of moonbounce tests with interesting results. By transmitting single CW pulses every 5 seconds and listening for echoes in between, Jim could gauge his ability to track the moon and also its potential for reliable communications. In one experiment, Jim detected 30 echoes out of 120 pulses transmitted, perhaps the first amateur record of the effect of the moon's libration.

In 1955 radio astronomers Kenneth Franklin and Bernard Burke were working on an antenna array in a Maryland field, when they accidentally discovered radio emissions emanating from the planet Jupiter. This was the first time that radio signals had ever been detected from another planet. These naturally occurring signals had a unique frequency near 22 MHz and were also detected the following year by Dr. John Kraus, W8JK, using a backyard interferometer.

It is interesting to note that in 1955 Walt Morrison, W2CXY, revisited the idea of using light waves to communicate via the

Photo 5. Reber's dish antenna now on display at the entrance to the National Radio Astronomy Observatory in Greenbank, West Virginia.

moon. The U.S. Army showed considerable interest in Walt's proposal but concluded the lack of a suitable light source would make it impractical for serious consideration at that time. It is interesting to note, however, that MIT researchers did bounce a light signal off the moon years before the laser was invented. The Army's response to Walt included a letter from astronomer Dr. John O'Keefe, the scientist who would discover the Earth's pear shape based on orbital data from the early satellites. After a lengthy discussion on thermodynamics, in which he explained why it would not be possible using current technology to communicate via the moon using terrestrial light sources, Dr. O'Keefe hinted at a possible means of reflecting radio signals from outer space that to my knowledge has never been investigated. Here's what he had to say:

"According to V. G, Fessenkov, the Gegenschein is a sort of tail of the Earth, formed from material driven by radiation pressure out of the high atmosphere. It is at a distance, he says, of about 80,000 miles, and subtends an angle of 3° to 4°. Is there any possibility of getting a reflection from it, on radio frequencies?"

Those familiar with optical astronomy will recognize the Gegenschein as a faint glow in the nighttime sky resulting from the backscatter of sunlight off microscopic particles on the side of Earth opposite the Sun. If such particles are capable of reflecting radio waves, the Gegenschein may present a unique alternative to moonbounce, especially since it is always there. Who woukd like to be first to give Gegenschein bounce a try?

In the 1950s, radio amateur John Kraus, W8JK, would come to invent yet another unique antenna, one even more significant than his flat top beam of the 1930s—the helical antenna. The circular polarization of this antenna makes it possible to communicate between the Earth and space with minimal interference from Faraday rotation. This makes it ideal for use in space communications, and such antennas were often employed in such work. However, Kraus recognized that arrays of such antennas could also be used to make sensitive interferometers, ones capable of detecting and discriminating various extraterrestrial radio sources. That contribution to radio astronomy not withstanding, Kraus's greatest contribution is perhaps the "Big Ear" radio telescope that he designed for Ohio State University (OSU). Similar to Reber's telescope, Kraus' instrument pointed south and used the Earth's own rotation to scan the sky. However, that's where the similarities end.

Unlike Reber's telescope, which tilted the entire parabola in order to view different elevations of the sky, Kraus' telescope used a fixed parabola spread out across an entire field, and a tilting reflector to direct the extraterrestrial energy into the parabola. The advantage of such an arrangement is that a much larger parabola can be created without having to worry about supporting and tilting its full weight and also maintaining its precise shape. True, it still required the Earth's rotation to scan the skies, but the impressive size of this instrument afforded Kraus unheard of capabilities. This instrument was used to create some of the most detailed radio maps of the heavens and to probe deeper into space and time than ever before possible.

One radio source identified using this telescope was named OH471. When optical astronomers analyzed the light from

this faint object they determined from its red shift value that is was located 90% to the edge of the universe, the most distant object known to man. In a way, astronomers were looking at the last milepost of the universe! This same antenna also captured the so-called "Wow Signal," which had all the earmarks of an extraterrestrial signal and to this day remains one of the great hopes of SETI enthusiasts.

By the late 1950s, the signature frequency of hydrogen at 21cm was about to provide yet another milestone in radio astronomy history. Of all the substances in the universe, hydrogen is the most elemental and also the most abundant. Having confirmed that hydrogen radiates uniquely at 1420 MHz, and further that such emissions could be detected using 20th century technology, suggested to more than a few scientists that if life existed elsewhere in the universe other civilizations might choose this frequency to communicate with others in the cosmos.

Three such scientists were Philip Morrison, ex-W8FIS, Giuseppe Cocconi, and Frank Drake. At that time the largest steerable dish antenna of any significance was the 250-foot dish at Godrell Bank, UK, run by Sir Bernard Lovell. Morrison and Cocconi wrote a short note to Lovell proposing the use of his dish in a systematic search for intelligent life in the star systems nearest the Earth. This appealed to Lovell, but apparently nothing happened. Nonetheless, the Morrison Cocconi papers are considered an important part of radio astronomy history.

Quite independently, Frank Drake was working at the NRAO in 1956 and thinking along the same lines. His so-called "Drake Equation" is now famous for laying out the distances that the most powerful radio transmitter on Earth could be detected

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IN REPLY REFER TO
Box 107, Red Bank, N. J.
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REPLYING TO

Mr. Grote Reber
212 W. Seminary Ave.
Wheaton, Illinois

My dear Mr. Reber:

Your letter suggesting that I make measurements of solar radiation in the region of totality at the time of the forth-coming eclipse of the sun has been received. Thanks very much.

I have had this eclipse in mind for more than a year and at one time I entertained hopes that the thing you are suggesting could be done. However, it has been evident for some time that the pressure of our war work would preclude the necessary long trip. More recently the situation has worsened and it may very well turn out that we cannot make measurements even here at Holmdel. I should think, therefore, that anything you might find it possible to do would have extraordinary significance.

Yours very truly,

G. C. Southworth

G. C. Southworth

Photo 6. Southworth's correspondence to Reber, dated 1945, lamenting to Reber his not being able to do more solar observing, mainly due to the war effort. (Source: <http://jump.cv.nrao.edu/dbtw-wpd/Textbase/Documents/grgc-southworth-reber-05161945.pdf>)

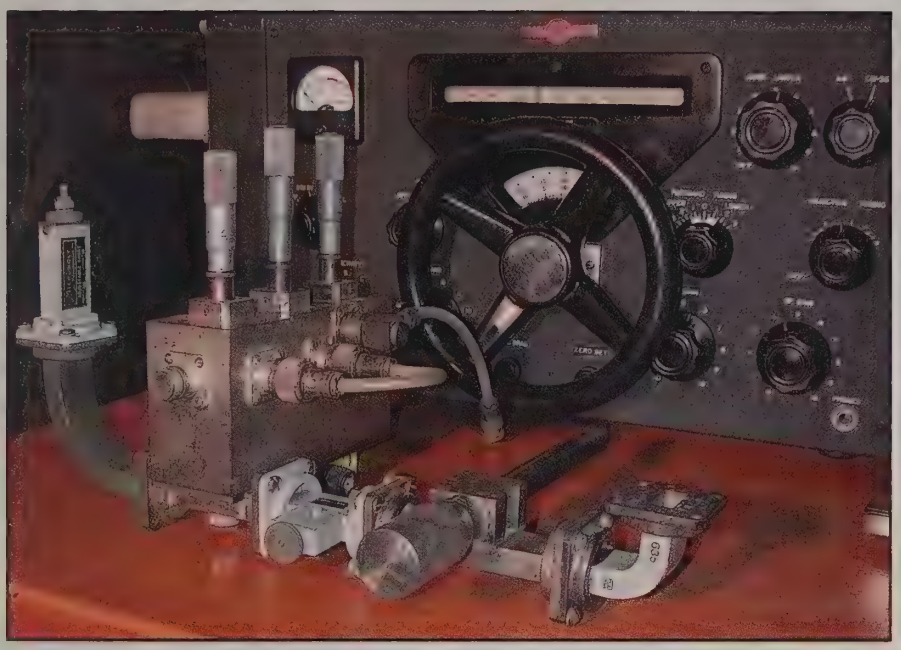


Photo 7. The Microwave Associates parametric amplifier owned by Walt, W2CXY, similar to the one used by Frank Drake, and now part of the Infoage collection at the former Camp Evans site in Wall, New Jersey. The Collins 75A4 receiver in the background is part of Walt's historic meteor-scatter and moonbounce station of the 1950s.

using the most advanced receiving apparatus on Earth at the same time. The result limited the search to just a handful of stars. At that time astronomer Otto Struve was in charge of the NRAO. Years earlier, Struve came to the conclusion that planetary systems were not unique to our solar system, based upon the irregular motion of certain stars. From this he concluded that planets must be circling those stars and, given the large number of such stars, the possibility that life existed on at least some of those planets could not be discounted. When Drake approached him with the idea of searching the nearest star systems at NRAO, using equipment that would also be useful in other work planned there, he was given permission to proceed with the idea. The only thing still needed was a sensitive front-end amplifier to use for the experiment.

In the late 1950s two important developments were made with respect to radio frequency amplifiers. At that time, most telephone and some television signals were transmitted across the country by a network of microwave repeaters spaced every 30 to 50 miles. These repeaters used microwaves in order to increase the number of channels that could be transmitted simultaneously.

When satellites came into being, one limitation was the power available for transmitting. As an example, the Telstar satellite used only a 3-watt transmitter. In order to get around this limitation, ground stations needed to have sensitive receivers. In those days, the cooled maser was the lowest noise receiving device in the world, and although somewhat complex, it was chosen for the earliest satellite experiments by Bell Labs in Holmdel, New Jersey. This type of amplifier would later play a role in radio astronomy, as we shall see shortly. The other type of amplifier was the parametric amplifier, which was less complicated but had higher noise levels than the maser. Invented by radio amateur Sam Harris, W1FZJ, who worked for Microwave Associates in Burlington, Massachusetts, this type of amplifier, in both cooled and uncooled versions, enjoyed many years of service in radio astronomy.

The head of Microwave Associates was Dana Atchley, Jr., W1HKK, who was so interested in the possibility of extraterrestrial communications that he published an article called "Speculations on Communications with Other Planet Civilizations" in the March 1960 issue of *QST*. In this article he suggested once again the possibility of life among the stars. When Atchley learned of Drake's need for a sensitive front-end receiver, he offered him one of the first parametric amplifiers in the world for use in Project Ozma, the name Drake assigned to the first Search for Extra Terrestrial Intelligence (SETI). Years later, in the January 1979 inaugural issue of *Cosmic Search* magazine, Drake recalled the day when this amplifier arrived at the NRAO facility in Green Bank, West Virginia:

"On the appointed day, sure enough, I got a call in my office that the chief engineer of Microwave Associates had arrived with the amplifier. Going downstairs, I got a real jolt but kept my cool as I saw before me: (1) A British sports car, top down , made by Morgan; cars used to be made of wood and this was the last of them, you know, complete with leather straps to hold the hood down. (2) in the driver's seat, a fellow with a long flowing red beard, and wearing a red tam-o-shanter. And (3) in the passenger's seat, the parametric amplifier which had bounced all the way from Boston. The driver was Sam Harris, known to every radio ham as a radio amateur magazine editor, and known to many and soon to me as an electronics genius. He had designed the parametric amplifier, and was the only one in the world who could make it work—and it really worked. He proceeded to install it, make it do its magic, and then taught me how to tune it, the task which became my four-o'clock-in-the-morning pick-me-up for the day. When all was well, he climbed back in his Morgan and drove off. I never saw him again until one day in 1966, when I met that red beard again; this time he was on the staff of my observatory at Arecibo (I had nothing to do with this improbable event), and he has been there ever since, doing his magic."

Photo 7 shows the Microwave Associates parametric amplifier owned by Walt Morrison, W2CXY, similar to that used by Frank Drake, and now part of the Infoage collection at the former Camp Evans site in Wall, New Jersey. The Collins 75A4 receiver in the background is part of Walt's historic meteor-scatter and moonbounce station of the 1950s.

Although Project Ozma did not detect signs of intelligent life in the cosmos, the type of paramp used by Frank Drake would play a significant role in amateur moonbounce experiments in the years that followed.

In Part 2 of this series we'll see further examples of the curious synergy that exists between amateurs and professionals as the quest to understand our place in the cosmos continues.

Was It E Skip or Tropo?

Both new and experienced operators sometimes make mistakes when trying to discern the type of propagation supporting a band opening. In order to help end some of the confusion, WB6NOA discusses some of the general differences between *E* skip and tropo propagation modes.

By Gordon West,* WB6NOA

At the SEA-PAC convention in Seaside, Oregon in June, several 6-meter operators were recounting their recent tropo contacts with KH7Y in Hawaii.

"I have never heard the tropo between Oregon and Hawaii as strong as it was over this 2500-mile path. At one point, Hawaii was coming in well over S9 for about 10 minutes," commented an Extra Class ham, obviously mistaking the double-hop *E* skip band condition for the summertime California to Hawaii tropo openings.

"I live just north of Dallas, and the Florida FM 2-meter repeater gave us a skip opening that lasted for a solid day!" remembered another ham, mistaking a likely tropo opening for short-lived summertime *E* skip.

Yet another ham commented, "It was like a rollercoaster. The signal was strong, then would take a momentary deep fade, and then the tropo would build back up again, cycling this way, over and over." Nope, not tropo.

Ken Neubeck, WB2AMU, author of the book *Six Meters, A Guide to the Magic Band,* describes *E* skip as regularly cycling strong to near disappearing signals within a 30-second time frame, and tropospheric ducting as moderately strong signals with gradual build-up and decay for hours on end. Sometimes tropo conditions will lead to moderately strong signals for days on end!

Sporadic-*E* Skip

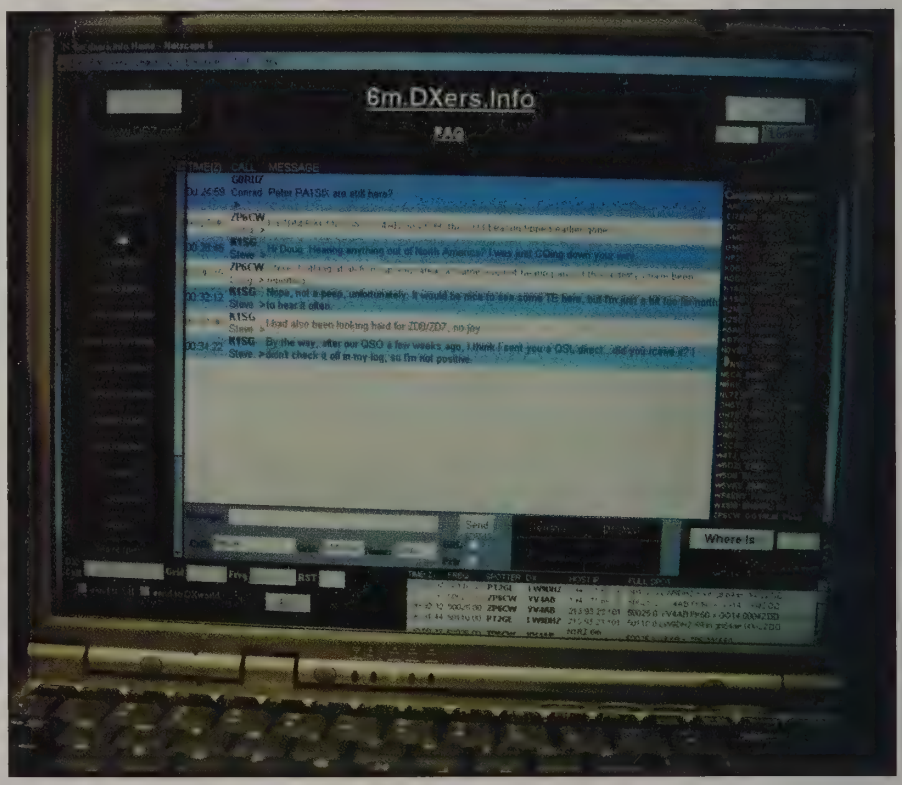
Good news! Sporadic-*E* skip occurs twice a year, no matter where we are in the 11-year solar cycle. As we just begin the climb of solar Cycle 24, sporadic-*E* VHF/UHF excitement may be just as strong now as it will be six years from now.

The *E*-layer of the ionosphere energizes every day at about 50 miles up. Sporadic-*E* VHF/UHF propagation takes place when radio signals *reflect* off drifting clouds of highly ionized *E*-layer particles, slowly moving from west to east. The reflections on VHF and UHF frequencies may be so "spot" intense that you may hear a station 1400 miles away, but your friend 10 miles away hears nothing! A few minutes later, *you* may hear your friend working sky-wave stations, and this time *you* hear nothing! Welcome to *E*-skip!

Sporadic-*E* skip gives Technician class operators on 10 meters CW and SSB some heart-pounding thrills. These 10-meter events can last for several hours, with every half minute peaks and valleys of reception. On 6 meters, sporadic-*E* creates lively contacts, with sometimes even double- and triple-hop cloud-to-cloud reflections which add some serious, short-lived DX to the 6-meter band.

On 2 meters, *E*-skip conditions to your specific location may only last for a few minutes, and your actual contact time won't last much longer than maybe 30 seconds. There is even a recorded 5-second contact on 432 MHz with Pat, N6RMJ, holding a brief QSO from southern California to the Midwest.

Sporadic-*E* skip on VHF and UHF peaks in May through August, with a secondary shallow peak in December and January. The best time to look for *E* skip



Computer propagation sites have all but replaced 10-meter band-opening alerts. (Photos by the author)

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e-mail: wb6noa@cq-vhf.com>

is mid-morning and late afternoon. At high noon, *D*-layer absorption takes its toll on DX.

The *E* skip patches of highly ionized "clouds" could be caused by charged particles from a single sunspot or could be caused by high-altitude wind currents that develop their own static electricity. Regular 6-meter/10-meter *E* afficioados claim they can anticipate a sporadic-*E* opening by looking at high cirrus cloud formations, yet others (in low-noise areas) claim they can forecast an imminent *E* skip opening by static discharge cracks passed through their DSP noise-reduction receiver audio circuitry. This is confirmed by John, N1OLO, of West Mountain Radio, who has recorded actual ionospheric "hiccups" using his Clear Speech DSP speaker circuitry just before the band magically, and suddenly, pops open.

Geometry of a typical *E* skip reflection works out to a little over 1400 miles. However, during periods of intense *E* "cloud clusters," double- and triple-hop events may lead to extraordinarily strong contacts such as the recent one from Oregon to Hawaii.

"I can give you a 10-minute heads-up before the 6-meter band is ready to open," commented Paul Lieb, KH6HME, the VHF/UHF voice of Hawaii. "I'll hear a hubbub of voices on the calling channel, 50.125, way down in the noise, minutes before an amazingly strong signal pops out of nowhere!"

Scanning for automatic beacons, between 50.060 and 50.080 MHz, is another great way to get set for *E* skip activity. Many hams also monitor the commercial FM music channels, 88 MHz to 108 MHz, for activity, possibly signaling *E* skip happening as high as the 2-meter band.

Now that most TV stations have gone digital and have been assigned UHF channel slots, many of us who dialed in to low TV-band analog VHF carriers are just discovering digital stations via sky waves. There are a handful of low TV-band stations above 54 MHz. It may be time to search out other sources of distant signals that could come in sky-wave under the right *E* skip conditions: <www.VHFDX.net/spots/map.php> and <www.DXWorld.com/50prop/html>.

Predictable Tropo

How is the weather? High-pressure weather systems will trigger long-range VHF and UHF tropospheric ducting.

Weather Triggers Openings

By Gordon West, WB6NOA

For a 6-meter and 2-meter sporadic-*E* bounce, high-altitude atmospheric conditions must be just right. These weather conditions are at the edge of our atmosphere.

Long-range VHF, UHF, and microwave contacts may occur with tropospheric ducting. The weather condition "on the deck" is one that you can feel as heat, smell, and observe with a local barometer. Be a weather "watcher" and you may be able to predict some terrific openings!

Sporadic-E

For the 6-meter and 2-meter sporadic-*E* openings, some experts track the jet stream. The powerful jet stream creates wind shear as river-like volumes of air pass through the atmosphere. The stronger the jet stream, the greater its amplitude in altitude, at times extending into the *E* region of the ionosphere.

Strong wind shears associated with the jet stream, lightning, and sometimes monster storms, strip atoms of some of their electrons, creating a collection of like-charged, mutually repelling ion clusters.

"Ions exhibit a collective behavior, which is why we call that collection of ions the ionosphere. These ions don't generally affect radio signals directly, but they do give a certain sense of direction to the free electrons," says Eric Nichols, KL7AJ, in a soon-to-be published book *Opus* about the technical side of ham radio (KL7AJ@arrl.net).

"Up here in Alaska, we use the HAARP ionosonde, which illustrates the electron density profile for the number of free electrons at any altitude, from 50 km to about 600 km," adds Nichols. Nichol's work describes these free electrons, around 250 km in altitude, which absorb and re-radiate radio signals, leading to exciting 6-meter conditions.

"I am reluctant to describe the ionosphere as reflecting radio waves. It is the acceleration of electrons that creates electromagnetic fields, not their mere movement. Our ions are basically floating on top of the atmosphere, and genuine weather effects down here on the surface *do* eventually transfer to the ionosphere," adds Nichols, suggesting that "electron precipitation may cause ions to travel down the Earth's magnetic fields, where they are dissipated, leaving holes in the ionosphere where 6- and 2-meter strong skip signals may drop into the noise levels for a few seconds."

"The ionosphere is inherently unstable. It's much like trying to float water on top of oil—the slightest disturbance will end up putting the water on the bottom, where it normally belongs. These magnetic fields are irresistible water slides for electrons," illustrating that it takes the right atmospheric conditions to trigger the elusive 6-meter and 2-meter sporadic-*E* openings.

Long-Range Tropo from 50 MHz to Microwave

Hurricanes traveling up from the tropics regularly create "tropospheric ducting." The troposphere is our weather layer of the atmosphere. With normal air, its temperature will drop 1 degree Fahrenheit for every 300 feet of elevation. Barometric pressure decreases logarithmically with altitude, and water content, within our atmosphere, decreases with altitude.

The long formula for calculating the refractive index of air is:
where:

$$N = \frac{77.6 \times P}{T} + \frac{3.733 \times e \times 10^5}{T^2}$$

P = atmospheric pressure in millibars
e = vapor pressure in millibars
T = temperature, Kelvin
N = the refractive index of air

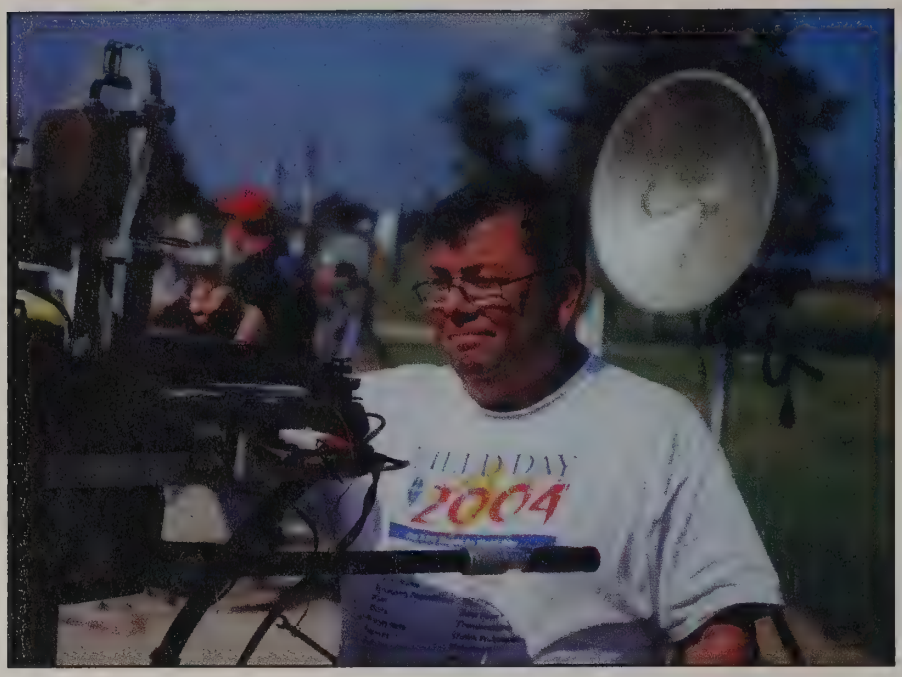
For easier calculations, $N = (n-1) \times 106$ gives us the refractive air as just a bit over 1 (1.000350) on the deck.

On a normal day, for every kilometer in altitude we could expect a change of 40 to 50 units. However, when warm, moist air from an approaching hurricane begins to overlay our "normal" atmosphere, our air becomes "squeezed" (greater pressure aloft), warmer (coming from the southern hurricane), and much more humid (again, the approaching hurricane). As this air stratifies within a high-pressure cell, VHF, UHF, and microwaves are refracted (bent) along the horizon with little attenuation. The Hepburn website mentioned in the article does all these calculations for you! Look for the red and purple propagation enhancements. As the more pronounced tropospheric ducting conditions thin multiple layers of atmosphere, these strata could lead to contacts as high as 10 GHz.

Summary

Weather in the troposphere leads to long-range ducting. Weather wind shears high in our atmosphere lead to the potential of sporadic-*E* clusters of intense ionization.

For a good source of more information on the material mentioned in this article, see the book *VHF Propagation: A Practical Guide for Radio Amateurs,* by Ken Neubeck, WB2AMU, and Gordon West, WB6NOA, available through the CQ Bookstore.



Pat, N6RMJ, 432-MHz record holder, working on his 10,000-MHz gear.

Unlike *E* skip, which tops out not much higher than 430 MHz, tropo may actually develop into waveguide-like DX, *increasing* in signal strength as the frequency goes higher!

"Depending on the depth or thin stratification of the atmosphere, the path between Texas and Florida may sometimes be slam dunk on 2 meters, yet a week later, the temperature inversion thins out to carry 70 cm like gang busters between our coast and their coast, with almost no propagation down at 2 meters," commented Larry Pollock, NB5X. "It all depends on the stratification within a stalled high-pressure cell hanging stationary over the tropo paths."

Range extension propagation within a tropospheric duct temperature inversion is the result of *refraction,* not simple reflection. Sporadic-*E* is usually reflection, and tropospheric ducting is usually refraction.

A common VHF/UHF tropo ducting event occurs when warm air from a developing hurricane rides north and overlays cool undisturbed (no wind) surface air. Hurricane-looking clouds spiral up from the south counter clockwise and ultimately settle over a region and then begin to sink. The air sinks because it formed up in a high-pressure cell surrounded by "normal" air.

Heavier high-pressure air sinking (called *subsidence*) then bottoms out about 500 feet from the surface of the ground or ocean. There is no mistaking a temperature inversion, as it's hot, sticky, and breeze-less due to the southern hurricane air approaching.

As the high-pressure subsidence begins to bottom out and stratify, single and multiple layers of warm and cool air develop a perfect waveguide for VHF and UHF radio waves – any mode, including FM and even my record-breaking reception of amateur television over a 2500-mile path from my southern California QTH to Hawaii!

Via computer (go to: <www.DXINFOCENTER.com/tropo.html), the Hepburn Report shows that 10-degree delta difference in stratified layers, usually illustrating enhanced tropospheric ducting conditions. But local hams may not need the computer.

"I can smell it, I can see it, and when I tune in on the 2-meter beacons, I can usually hear it!" commented Chip Margelli, K7JA, who has an uncanny knack for predicting tropo and weather-related openings. His recent trip to Ham-Com in Texas gave him a close-up look at colliding air masses, and the sometimes range-extension ducts that may form along the line of descending storm cells.

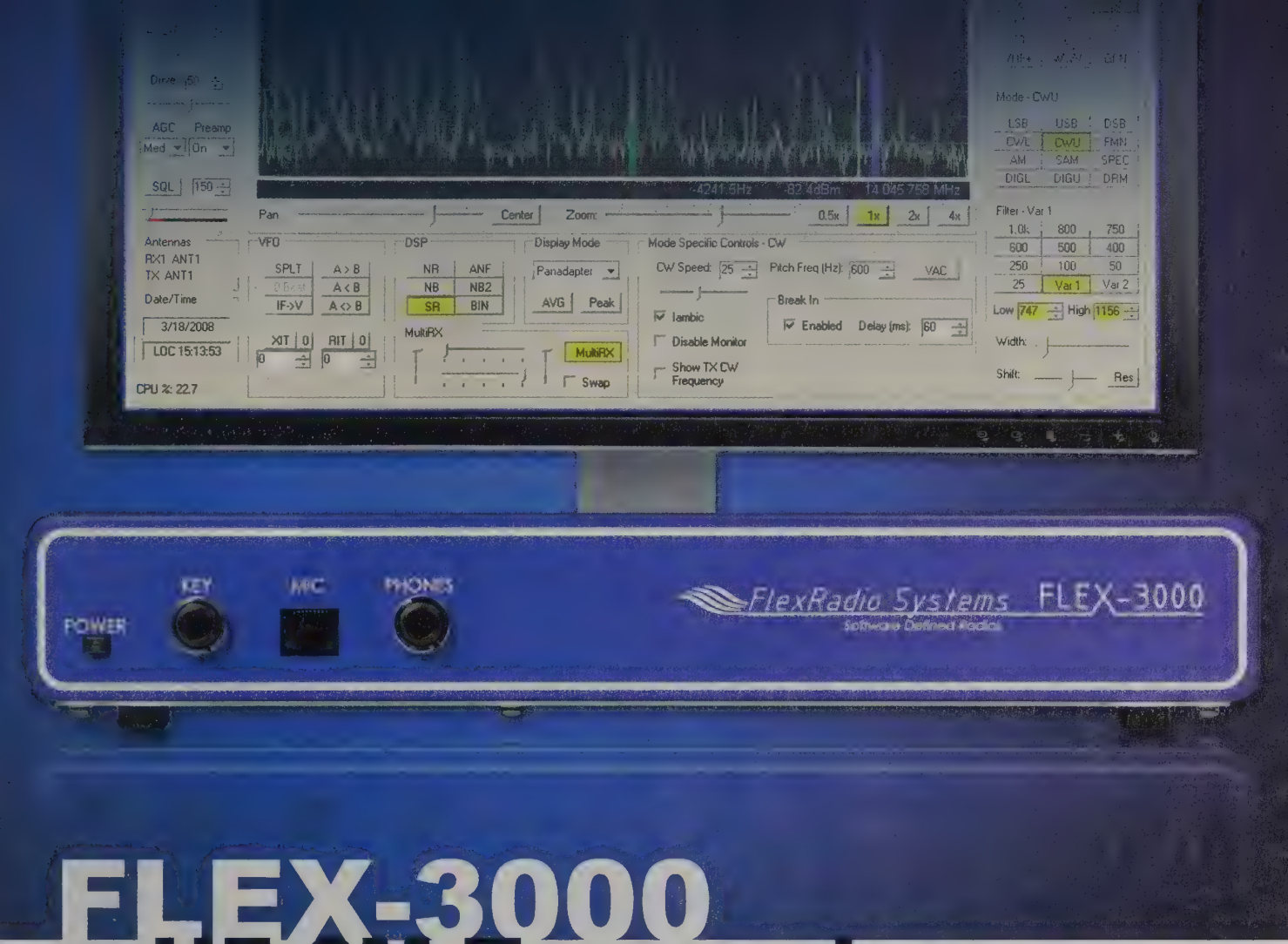
The Hepburn Report is ultra accurate, but just looking over local weather maps and spotting high-pressure cells is another great way to predict tropo VHF/UHF openings.

"Just go outside and sniff, look for the brown haze (which we call smog) just hanging on the horizon," added Margelli.

The typical tropo DX event has signals building over a 30-minute period with relatively constant signal strength, without the huge momentary fades of a sporadic-*E* signal. The refractive tropo duct opening may not be as strong as the reflective *E* opening, but the tropo duct may extend well over 2500 miles for days without major signal fades.

So, next time DX pours into your 6-meter or 2-meter transceiver, consider weather conditions or the *unpredictable* sporadic-*E* events and decide for yourself whether your DX operation will last for minutes with *E* skip, or maybe hours, or even days, when the tropo moves in!

DSP add-on modules will improve weak-signal SSB and CW reception.



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An Interview with the "Fire Tower Man" of Tennessee

My friend Melvin, K4JFF, had often told me he could routinely work a station in Tennessee on 2 meters simplex from his house in Atlanta, Georgia, and that this ham has a fire tower atop a mountain there. It intrigued me from the start. This is the story of my search to learn about the tower and the man who built it.

By Jorge de la Torre,* KI4SGU

Photo 1. John Williams, N4AOW's tower is at the top of a mountain in Tennessee (notice the small specks in the fields below; those are cows!). (All photos by Kevin, N5PRE, unless otherwise noted)

Many hams have 100+ foot towers for their VHF/UHF antennas. However, John Williams, N4AOW's tower is at the top of a mountain in Tennessee (see photo 1 and notice the small specks in the fields below, as those are cows!). After first hearing about his tower, I thought that this must make for very short antenna runs, but was quickly reminded that he would have very long ground leads. From the moment I heard of N4AOW's tower setup, I knew I had to meet John and visit his QTH. I finally got my opportunity to meet him at the Dalton (Georgia) Hamfest on a frightfully cold day in February 2008.

When I met John, there was a bit of a mental disconnect for me. This legendary ham could easily talk across state lines on 2 meters, defying the curvature of the Earth itself, but the quiet, soft-spoken gentleman before me did not quite fit what I had imagined. As I spoke to John more and more, I came to realize that the magic in all of John's accomplishments is the thousands of details he meticulously handles. To him it is not all about raw, brute power; it is all about the details.

As a ham and an amateur engineer, I was more than a little intrigued as to how a ham would acquire and operate his own 90-foot steel tower atop an equally impressive ridge line in the foothills of the Great Smoky Mountains (technically the northern end of the Red Hills of southeast Tennessee). One detail, which I came to find out later, is that John had acquired not only the tower but also the land with this project in mind. He then finally built the house that is now his home. Wow, that is dedication to the hobby!

During that first meeting, as we walked and talked amidst the cold bone-yard at the hamfest in northern Georgia, we turned the pages of his photo album, an album that John had compiled as a record of the construction project. My very first question was "Wherever did you find a surplus forestry service tower?" "In Sparta, Tennessee," he said, adding, "for about $300 in the summer of 2001." The tower also had lots of its key parts missing. Apparently, the previous owner had had the tower for a similar project, but had never been able to complete it and had lost many of its parts along the way before selling it to John. I wanted to visit and operate from the shack, and not just the turn the pages and view the pictures. As people often do, we vowed a most excellent and expedient plan for later that year when we would visit the tower and see for it ourselves. I optimistically figured on a few months at the longest, when the weather had warmed up a bit and I would make the trip to John's home in Cleveland, Tennessee. But alas, work and family and all of the other normal

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pressures of life conspired against me and kept me from making the trip.

When the 2009 Dalton Hamfest was announced again for February, it signaled the anniversary of my failure to carry through with the visit. I decided to call my friend Melvin, K4JFF, via ham radio of course, and arrange to set a new date to finally visit John and his tower. We simply would meet at the hamfest and follow John back to his QTH. This time we would right the wrongs and make the trip we had missed out on the year before. (For some reason, Dalton mirrors Punxsutawney, Pennsylvania, with its quaintness, which is in contrast to my more normal, metropolitan environs of Atlanta).

The Tower

Driving through the Tennessee countryside following a collection of now smudgy printouts from Google® Maps, we were slowly making our way through a picturesque sea of pastures and cows. My old GMC van was straining to get up John's rather steep and long driveway, and all I could wonder is why I couldn't see the tower whose transmissions I could hear in Atlanta. The reason is that the tower is nestled deep in the woods, and it is really hard to see. Just a brief walk through the backyard and we were at the base of the tower (see photo 2). Once there, we were eager to pick up where we had left off the year before. We slowly climbed higher, through the center of the tower, and the handie-talkie on my belt came alive with the sounds of an Atlanta repeater (120 miles away). It had been tuned and then forgotten about as we left Mel's place hours earlier.

We began talking about the construction of the tower. John correctly pointed out that the construction came much later in his story. After acquiring the tower, figuring out how to put it together had been a much longer and tougher issue than I had given him credit for in my rush to get to the fun stuff. Like trying to put together a really big bicycle on Christmas morning, but without any instructions, this "present" was close to 90 feet tall, weighed tons, had random missing pieces, and there was no toll-free number to call for some technical hand-holding.

At the beginning of the project, not having engineering drawings or blueprints was more than a bit of a slowdown for John. As John explained, he started by talking to area forestry old-timers who remembered some details about the tower in its glory days, but that left out too many details. He located a still erect tower across the state line near Ringgold, Georgia. That tower was a reasonably close stand-in to his own, and he could now climb it, making measurements and drawings and trying to identify the hundreds of metal members that might resemble his own lying in a heap in his yard. He spent seemingly weeks just measuring the hole spacings and angles on the struts.

During this period John found out that his tower had been built sometime in the 1930s by the Aermotor Windmill Co., and the more he learned the harder the project seemed, as he came to realize that dozens of parts—over 2000 pounds of steel—were missing and would be difficult and expensive to recreate.

We already knew that he had purchased the original tower for about $300, but the rest of the tower cost a little more. How much more took a little more prodding to find out. John is a quiet, humble man, preferring to let his actions talk more than his words. When he does speak, it is in mellow tones, sounding much like a Faulkner inspired gentleman from the bygone South. Therefore, when we first asked about the total project,

Photo 2. John's tower nestled deep in the woods.

John simply said it cost him "a lot." Later, when we pressed him further, he admitted that it cost him at least $8000 (notice, he said "at least"). Having said that, he quickly pointed out that included in the $8000 was another whole tower, as he purchased a 47-foot tower to cannibalize. The current tower owes much of its top 40 feet to that smaller second tower from Sales Creek, Tennessee. The second tower was also built by the same Aermotor Windmill Company.

Now that the story was out in the open, the rest started to flow easier. John stated that he could maybe build yet another 30-foot tower with just the spare pieces and junk left over from the original build. That led us to a logical leap of hope, and I asked him if he would ever consider building a tower for another ham—perhaps me. John just laughed, giving no answer, as he is too polite for a "no," although he commented that once having built one, a second would be much easier. Seeing how far we could push this line of inquiry, we asked if he would do anything differently if he had to do it all over again. After a brief pause, he chuckled and said he should have gotten a bigger one, maybe one of those 100+ foot towers now available in Florida. Ahhh . . . for the clarity of hindsight.

Now, as the word slowly spread about John's project, some help came from many unlikely places. For instance, the

Photo 3. Civilian Conservation Corps (CCC) enrollee Thales Bay of Orin, Illinois, at work on a fire tower, Camp Ingram, Fremont National Forest, Oregon. (Photos 3 and 4 courtesy of Oregon State University Archives' photostream, <http://www.flickr.com/photos/osucommons/3226888156/in/photstream/>)

University of Tennessee at Chattanooga was able to secure the set of blueprints for a similar tower in their forestry archives, thereby enabling John to plan and execute his foundation and base design. With the newly found drawings, he was able to have more confidence about the project, and not only for himself, but for the county inspectors, who eventually gave him their full blessings once they realized John was planning on over-building the base by a factor of 10 and that the tower would be built to withstand 120-mph winds.

This was not a project for the faint of heart, nor for one afflicted with acrophobia. This thing is huge, the climb is steep, and it is perched atop an already tall hill, surrounded on all sides by the stunning beauty of southeast Tennessee. John makes this seem much easier than it really is, but then he is a professional steel and metal fabricator at a factory in nearby Cleveland, Tennessee.

The History

In preparation for this article, I became a bit of a tower expert myself, finding out some of the history about the towers themselves. The towers were originally designed back in 1926 as "Bilby towers," named for their designer Jasper Bilby. As mentioned before, these towers were built by the Aermotor Windmill Co., which went on to build most of the nation's forest observation towers. These fire towers were amazingly narrow at the top due to their windmill pedigree; this allows for only the coziest of shacks near the top. My web searches also yielded that the company is still in business <http://www.aermotorwindmill.com>. They are still building windmills and towers, but mostly for rural water-pumping systems.

The original need for these fire towers was increased by the Great Fire of 1910, a wildfire that burned about 3-million acres in northeast Washington, northern Idaho, and western Montana in just over two days and killed 87 people. Arguably the largest US forest fire in recorded history, the smoke from the fire drifted across the entire country to Washington, D.C., both physically and politically. This energized and challenged the then recently created US Forest Service to address new policies regarding fire suppression and monitoring, prompting towers to be built across the country. In 1933, during the Great Depression, President Franklin D. Roosevelt formed the CCC

Photo 4. Forest-fire training at Skagit CCC camp, Mt. Baker National Forest, Washington.

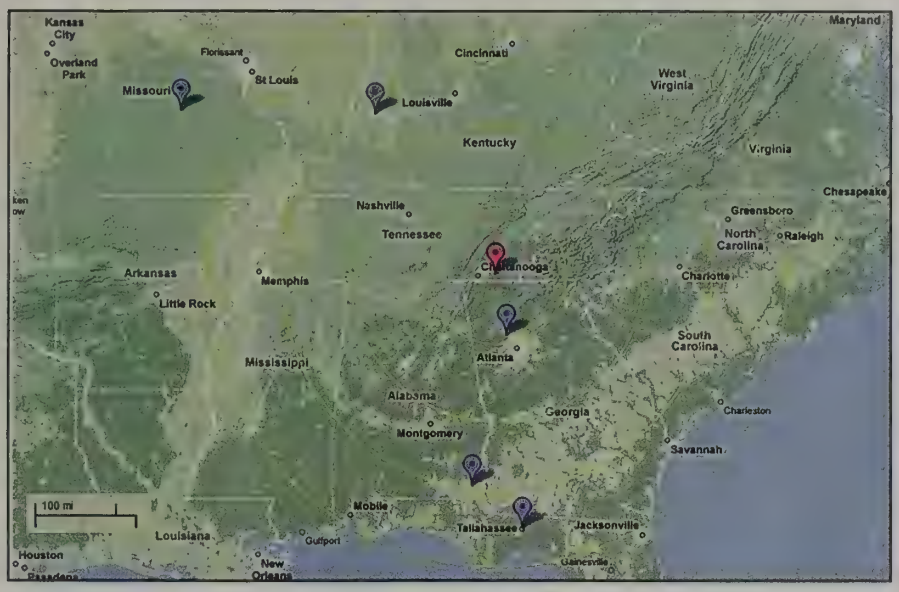

Figure 1. A map of some of the places with which John has regular QSOs.

(Civilian Conservation Corps). The CCC was a public work relief program focused on natural resource conservation from 1933 to 1942 and was for unemployed young men and veterans of World War I. It was during this time that the CCC set about building fire lookout towers and access roads to those towers (see photos 3 and 4). By the late 1930s there were about 8000 fire towers in the United States.

The golden age of fire lookout towers was from 1930 through 1950. During World War II, fire lookouts were assigned additional duties as enemy aircraft spotters. However, from the 1960s through the 1990s the towers took a back seat to newer technology, aircraft, and improvements in radios. The further promise of space satellites for fire detection was the last nail for the towers, and many now sit idle, sentinels to the past.

The Man

To understand the tower, it may be easier to focus on the man who built it. John, N4AOW, like many other hams, became interested in radio via the CB craze in the 1970s. With the help of his Elmer, Bill Adams, KE4QS (SK), he got his Technician's license at the age of 16 in 1978 and then went on to General a year later. He has always had the call N4AOW. His main interests are VHF and UHF, although he has enjoyed lots of HF over the years. He looks forward to getting back onto the worldwide bands. We often tease John about his spanking new Kenwood TS-2000, which is still in the original shipping box, because he is having too much fun on VHF and his tower, not having found the time to unpack it. Operating mostly 2 meters FM, John routinely checks into nets two states away!

With boyish excitement in his voice, John told of recently working a repeater in Evansville, Indiana (his original hometown) with less than 1 watt. He has regular QSOs with hams in Tallahassee, Florida and Dothan, Alabama, and I've even worked him simplex from my garden-variety 50-watt mobile in my Jeep on the north side of Atlanta (see figure 1). In the evenings on my commute home, I can count on his signal to crackle in on 146.52, his signal becoming a boom as I clear the ridge north of Kennesaw, Georgia on I-75. He believes his farthest 2-meter QSO was when he recently checked into a net in Rolla, Missouri, more than 500 miles away. Not bad for FM! I'm sure those guys in Missouri were a bit surprised.

John has been known to drive 100 miles to lend a hand to help stranded hams on I-75 with minor automotive emergencies who had called out on 2 meters simplex, acting as his own dispatcher.

I know that you may be thinking that making these kinds long-distance calls you would need a lot of RF power, but you would be wrong. If you would like to get a taste of what a tall tower and antenna in a great spot can do on 2 meters FM, how about a slightly fuzzy 50-milliwatt QSO

Photo 5. The largest and most prominent antenna on John's tower is a 23-foot tall Diamond X700 vertical dual band.

using a pair of Kenwood THF6s HTs. John and Mel can easily work one another, but lest it seem like bragging, Mel, too, lives atop a rather spectacular piece of 1300-foot msl real estate. His house and antenna farm are on the pinnacle of the historic Pine Mountain, just north of Marietta, Georgia, the site of a rather dubious Civil War battle, where poor General Polk met his untimely demise from one of General Sherman's howitzer batteries. Mel is also an amateur historian, and he has shared the story with me.

The Antennas

The tower is well appointed with antennas of different types for each of the bands to be worked. The largest and most prominent is a 23-foot tall Diamond X700 vertical dual band (see photo 5) This antenna enjoys a large capture area, and John has built a jack-knife and retractable mast, which telescopes to 110 feet. This means the tip nears at 133 feet on the northwest corner of the tower. This is the workhorse of the antennas, being used for most general 2-meter and 70-cm FM work. A corner reflector (see photo 6) offers a bit more gain and has nice side rejection, placed just above the top hand-rail at 95 feet. When he works 220, he uses a Hustler G7 mounted on the southwest corner of the tower. For additional 220 stuff, he also has a 7-element Yagi.

Photo 6. A corner reflector offers a bit more gain and has nice side rejection, placed just above the top hand-rail at 95 feet.

Understandably, John's greatest concern while operating with his tower is lightning. The tower has lots home-brewed lightning-arrestor systems, and he seems to enjoy experimenting with this extreme aspect of the ham radio hobby in sort of reverse QRP. He tells us that after a good storm, and once the actual lightning has stopped, he will climb the tower and can pick up the residual energy in the air. He does this by dropping the squelch control on the radio tuned on a dead channel. Normally this shows nothing (you should try this on your own radio), but hours after a strong storm the meter shows as much as S3. That is residual energy, and the radio is not the only thing that can sense it. Sometimes John can feel it, too. He has heard war stories from many of his friends who have first-hand knowl-

Photo 7. John's station consists of a 2m/440MHz Yaesu FT-8800 matched with a 160-watt Prodigy Amp and a 220 Alinco DR-235MKIII coupled with a Mirage 1012 amp, 120 watts. Either can be mated to a West Mountain Radio CLR DSP audio processor.

edge of lightning strikes, with no one actually getting hurt, but close enough for John to be careful and take it very seriously. However, one has to enjoy "being in the weather," as John puts it. He remembers being up the tower after the remnants of Hurricane Katrina went by near the Tennessee/Georgia border, with 55-mph wind gusts.

To complete the scene and tune in those afternoon games or to help with weather and news, he points out the TV, which is also technically a UHF device and integral part of his shack. His reception is just so-so, but one needs to understand that his TV antenna is a piece of coax with just 4 1/2 inches of insulation trimmed off mounted to the side of the tower and no antenna at all! He enjoys checking in and helping out with many weather nets, being somewhat part of the weather himself. He maintains a fully automated weather station on his tower, positioned just above the flat-screen TV, to help him gather this information, which he shares with the National Weather group. He believe he is the only ham in his county to talk directly to the National Weather Service in Morristown, Tennessee.

To help lower his lightning profile, the vertical Diamond Antenna can hand-crank down and fold over. This brings it below the top of the tower's flag-pole/lightning arrestor. The grounding system is a series of #2 copper wires from the top of the flag pole, the highest point of the structure, where the X700 is stowed, to four ground rods at the base.

The Radios

After the complexity of the tower, the radios are neat and simple (see photo 7). The station consists of a 2m/440MHz Yaesu FT-8800 matched with a 160-watt Prodigy Amp and a 220 Alinco DR-235MKIII coupled with a Mirage 1012 amp, 120 watts. Either can be mated to a West Mountain Radio CLR DSP audio processor, and boy what a difference that gadget makes, even on FM!

Just think of working 14 states on 2 meters FM with the same Yaesu FT-8800. The FT-8800 also is the height of comfort, really helping out by cross-banding when John wants to be downstairs minding his grill and entertaining friends. He can still tune to UHF one of his vintage HTs from his extensive collection. Meanwhile, the FT-8800 booms out on VHF from the shack. He has a solar 5-watt panel with a 32-amp/hr battery (he plans to erect a 45-watt solar panel soon), and he also has a small 1500-watt generator to complete the gear in the shack.

Just as the original designers had intended, the operating cabin has a commanding view of 360 degrees. On a clear day one can see into Tennessee, northern Georgia, and into parts of Alabama and North Carolina. John can hit remote repeaters on "all SERA repeaters pairs" on the band, sometimes firing off three or more repeaters, making the proper use of PL tones by all involved of the utmost importance.

The main part of the construction took place between February 28 and June 6, 2003, when the top was hoisted. The foundation and base had been put in place a few years before. However, I doubt he will ever actually finish it, as he continues tinkering with improvements. I often hear from hams about the lack of activity on 2 meters FM simplex, and my advice is simple: Tune in on some evenings and you might be surprised to hear a mellow voice from Tennessee. You might hear N4AOW on your commute home.

Summary

Although the trip did take place as depicted here, the day I traveled to John's house was another cold and rainy late winter's day, so we were not able to take any decent pictures of the tower and the surrounding area. Thus, the pictures you see here, and much of the technical details, came from a second trip that I was not able to go on. Ham buddies Mel, K4JFF, and Kevin, N5PRE, came to my rescue and made the trip for me, Mel asked the questions and Kevin took the pictures. This article was written based on an audio recording they made of their trip. Isn't technology wonderful?!

A special, warm thanks to:

Melvin Dishong, K4JFF <k4jff@aol.com>, amateur historian and 40-plus year ham radio operator.

Kevin, N5PRE, <radiotube@gmail.com>, amateur photographer and collector of vintage radios. Many more pictures were taken for this article than we have room for. If you would like to see more tower pictures, visit Kevin's flicker site: <http://www.flickr.com/photos/kt/sets/72157619669149451>.

And of course John Williams, N4AOW, for helping me prepare this article.

Additional Resource

If you are interested in building your own, check out "Fire Towers For Sale!" on the web at: <http://www.firelookout.org/TowerSales03.htm>.

Six-Meter Paths of Glory

While others have been lamenting the lack of sunspots for the past few years, WB2AMU has been researching what happens on 6 meters when there is a lack of sunspots. In particular, he is interested in seeing if there is a correlation between the lack of sunspots and an increase in multiple-hop sporadic-E propagation. Here he presents the results of his research.

By Ken Neubeck,* WB2AMU

As did the summer of 2008, the summer of 2009 represents a unique opportunity for 6-meter operators to take advantage of the quiet geomagnetic conditions associated with the long solar minimum in the area of long-range multiple-hop sporadic-*E* contacts. Geomagnetic activity generally has been observed by 6-meter operators to be an impediment to sporadic-*E* conditions, particularly when geomagnetic storms occur such that these storms create aurora activity, as was experienced in the June 2004 VHF contest, with little sporadic-*E*.

Last year, *CQ VHF* presented a series of articles on the U.S. to Japan contacts that were made on 6 meters during June 2008. As suggested in the articles, the quiet solar activity allowed for multiple-hop sporadic-*E* activity to occur, particularly in the links over the aurora zone, which have been suggested to be a PMSE (Polar Mesophere Summer Echo) related phenomenon.

At the time of this writing, with the current solar activity there is reasonable expectation that similar events may occur this summer as well between the US and Japan. There also may be some new discoveries that could result in "first" contacts between different countries on 6 meters. The key is that some hams in different areas of the world, particularly in the equator and Northern Hemisphere regions, listen consistently on 6 meters. Hams in new locations on 6 meters are going to be at the forefront of some of the new multiple-hop paths that are going to be discovered.

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History of Sporadic-*E* Tracking

In 1957 a graduate student by the name of Dr. Ernest K. Smith wrote a thesis for his doctorate degree that would later become a scientific book, *Worldwide Occurrence of Sporadic-E,* published by the National Bureau of Standards, then a part of the US Department of Commerce. It is probably the first book that was dedicated to the phenomenon of sporadic-*E*. The book made extensive use of worldwide ionosonde station data that was collected from 1948 through 1952.

The majority of ionosondes were set up shortly after World War II, and they consisted of a transmitter that put out a sweep spectrum of frequencies from 1 to 20 MHz in a straight-up or vertical path. Any return signal that reflected off a formation in the ionosphere could be measured and recorded as the critical frequency (f_o).

The hourly data collected by the different ionosondes was used to generate the worldwide maps that were used in Smith's thesis to tabulate the percent of sporadic-*E* occurrences where f_o is greater than 5 MHz. An f_o value of 5 MHz represents an MUF (maximum usable frequency) almost 28 MHz, as shown in figure 1. One of the maps that Smith created is presented in figure 2. Note that there are no ionosonde stations located in the equatorial zone to collect sporadic-*E* data.

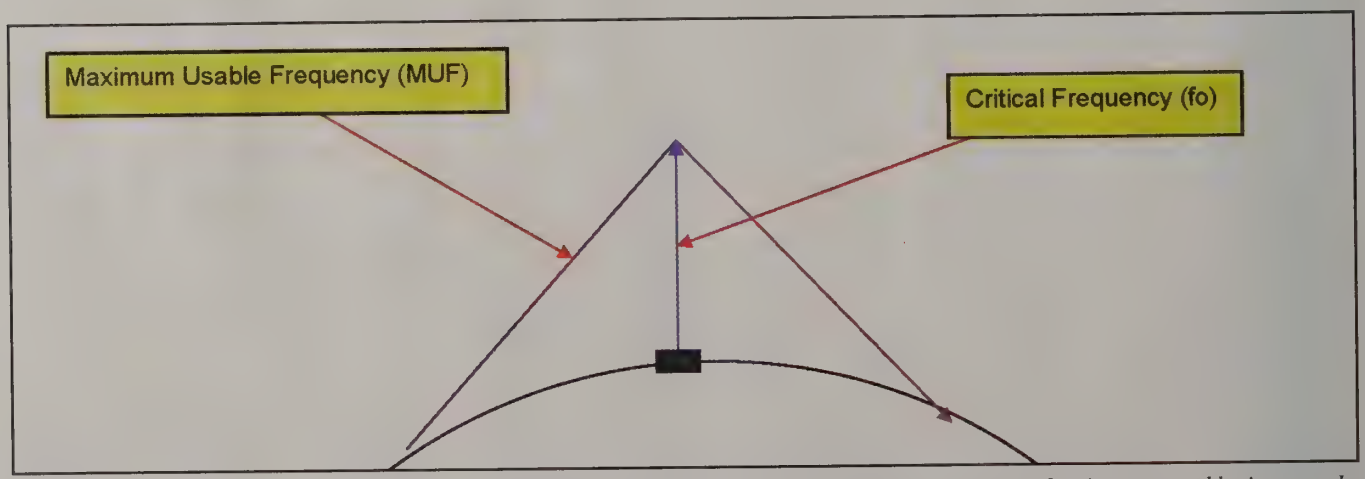

Figure 1. This diagram shows the graphical relationship between MUF and the critical frequency that is measured by ionosonde stations that use sweep frequency in a vertical direction. MUF is approximately 5.3 times the critical frequency.

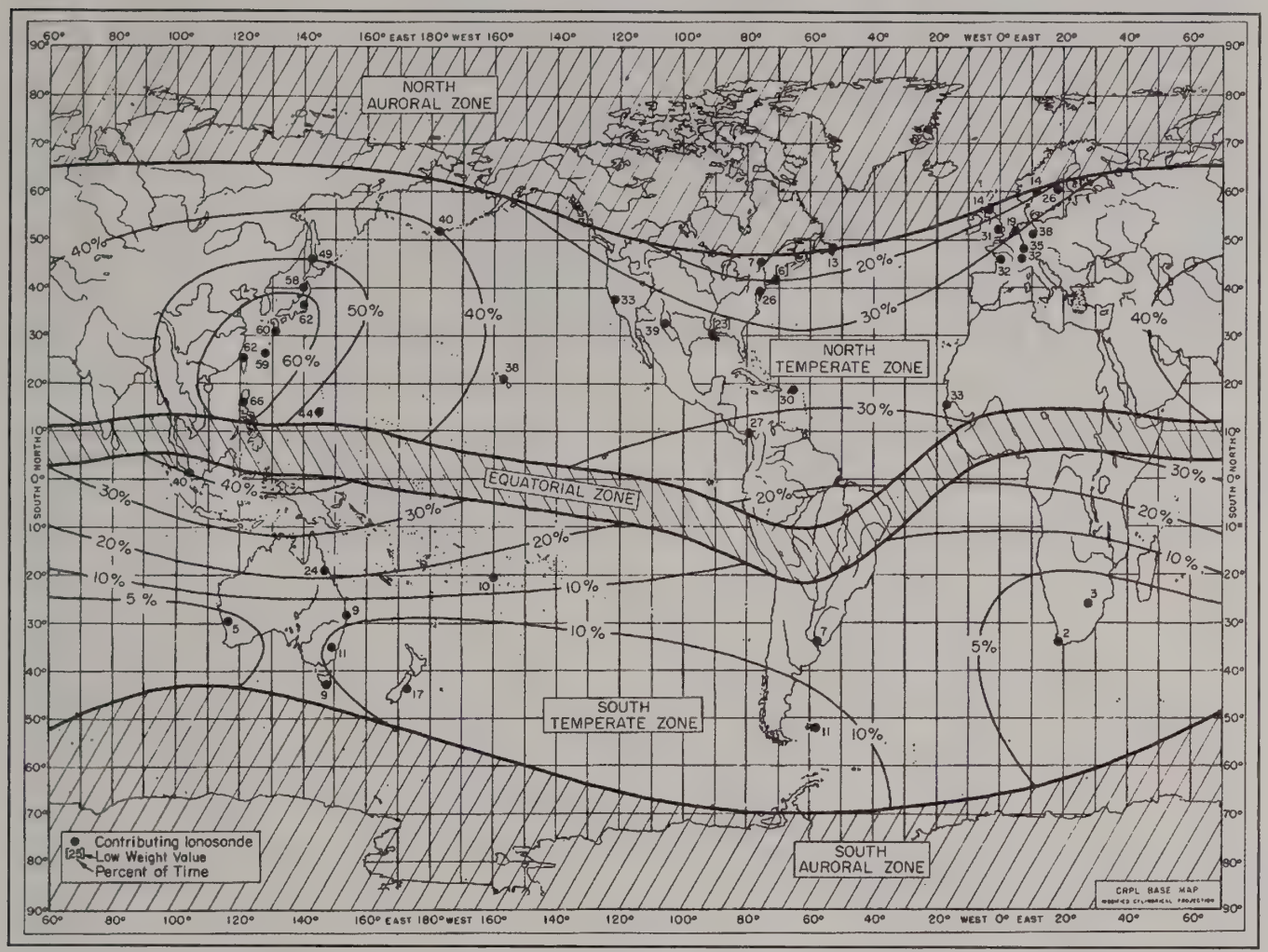

Figure 2. Worldwide plot by Ernest K. Smith of available ionosondes (1948 to 1952) for summer months 0600 to 1800 local time. (Courtesy of Ernest K. Smith)

Later on more stations were built, including seven additional ionosonde stations that were located inside or just outside the equatorial zone. Of particular interest is the station that is located in Huancayo, Peru, where incidents of sporadic-*E* during the summer months (May, June, July, and August) were measured over 80 percent of the days during 0600 to 1800 local time. The data that Smith and others collected during the International Geophysical Year (IGY) included these additional stations (see figure 3). It is striking to realize that the incidence of sporadic-*E* is very high in the equatorial zone and was later noted by scientists to be a special type of sporadic-*E* known as Equatorial Sporadic-*E* (ESQ).

This bit of history is meant to provide a backdrop for what hams have been observing on 6 meters over the years, including the time immediately after World War II. (The 6-meter band was granted to U.S. hams in March of 1946!) Because the 6-meter band was not granted to hams around the world for years after 1946, most of the long-range contacts that were made were between the U.S. and Canada or the U.S. and the Caribbean or South America area. The absence of much activity on 6 meters in Europe (except for Ireland) made it impossible to gauge the long-range DX capability of the band.

Six-Meter Multiple-Hop Sporadic-E Paths

Just like Dr. Smith did in updating his worldwide maps showing the incidence of sporadic-*E* to include additional stations along the equatorial zones, 6-meter operators are updating their knowledge base concerning multiple-hop sporadic-*E* openings in recent years. The almost consistent nature of contacts from Japan into central U.S. during the summer solstice period of 2008 showed that this may be a regular path that is aided by the low geomagnetic activity situation during the solar minimum. Also, a number of things have contributed to capturing these events during recent years. These include the following:

- Internet spotting sites for 6 meters (ON4KST chat page).
- Better receiver designs and more use of directional 6-meter antenna setups.
- Hams being active on 6 meters in areas not previously on the band.

I also believe that in addition to the above, a major key in the discovery of the Japan to U.S. path was when Japanese stations heard the Alaska beacons on 6 meters at the same time that central U.S. stations were hearing these same beacons. Thus, the path was a northeast path that left Japan, whereas the path from central U.S. follows a northwest path to the

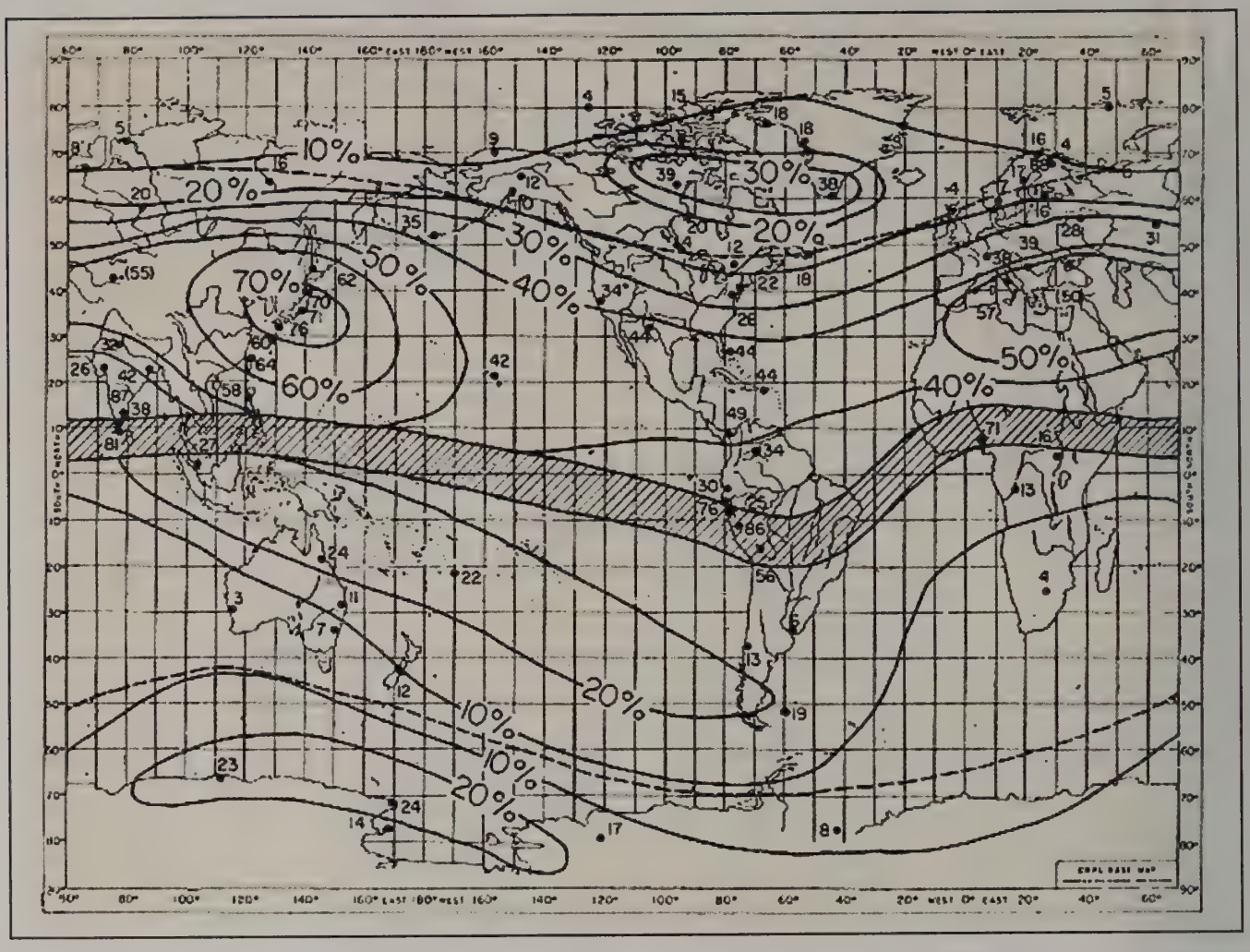

Figure 3. Worldwide plot by Smith of available ionosondes, International Geophysical Year 1957/58 for summer months 0600 to 1800 local time. (Figure courtesy of Ernest K. Smith)

area of Alaska. One could argue whether the path is five- or six-hop sporadic-*E* or four-hop sporadic-*E* aided by an arctic phenomenon, as previously discussed in articles in *CQ VHF* last year. However, the main point here is that the specific direction for hams with directional arrays to point their antennas is the key for the path to work stations!

On May 20th of this year, I came home around 5 PM local time and had about five minutes to spare to listen on the radio before I had to go out. I tuned the dial and on 50.105 I heard a CW signal that turned out to be Jack Henry, OA4TT, in Peru! On the second try, I was able to work him with 559 signal reports both ways. He was the only signal that I was able to hear on the band. I had to rush out again, and I did not think too much about the path, which I thought was double-hop sporadic-*E*.

However, later on, I saw that where Jack is located is near the geomagnetic equator, and because of the distance, the path had to be either a triple-hop sporadic-*E* path or possibly a sporadic-*E* *path* plus a TEP (transequatorial propagation) link. After discussing this with other veteran 6-meter operators, the former seemed to be the more logical path, as the location of OA4TT was not quite in the TEP range, nor was TEP activity particularly high during that part of month and during this point in the solar cycle. If a triple-hop sporadic-*E* path was probable, it is amazing that at any time during the summer a sporadic-*E* path can occur, even one with multiple hops!

Another example of this happened to me on June 22, 2001. I was listening from my car at 12:30 PM local time using a homemade two-element beam that was facing southwest when I heard a very loud sideband signal come booming in. It was PE9PE in the Netherlands, and I quickly turned my beam toward the northeast. He was several dB over 59 signal strength. I worked him with no problem, and shortly thereafter, the late K4MZ in Florida worked him. From my location on Long Island, New York to the Netherlands is at least two hops, and most likely three hops of sporadic-*E* skip. However, for K4MZ, this would have meant at least another hop (I heard both him and PE9PE), meaning possibly four-hop sporadic-*E*. Again, I tuned around the band and heard no other signals. There was no likelihood that any *F*-layer skip was involved, because it was the summer.

As previously discussed in an article in *CQ VHF*, double-hop sporadic-*E* is an occasional phenomenon on the 6-meter band, particularly during the months of June and July in the Northern Hemisphere. It may also be that the likelihood of three-hop and four-hop sporadic-*E* paths is greater during parts of these two months as well—hence the Japan to U.S.

openings that occur during the weeks surrounding the June solstice.

For those of us who are located in the northeast part of the U.S., there are three or four key stations in Europe that we listen for every summer. These include Jose, EA7KW, Gary, CU2JT, and Joe, CT1HZE. A number of veteran stations in the Northeast look for European TV video in the 48-MHz range as a possible early indication of a transatlantic opening on 6 meters. However keep in mind that the TV stations are very high powered and there is still a 2-MHz difference in order to reach 50 MHz, which sometimes seems like an insurmountable gap. Hence, the active European stations tend to be a better indicator.

Joe, CT1HZE, has been one of the more active stations that I have been able to work consistently when there is any semblance of a transatlantic opening. We have an agreement that we will work one another when we hear each other on different openings, as this adds to our observations. In 2008, I was able to work Joe on two different days in late June, four different days in July, and on August 1st. This was one of the best years for me for working transatlantic, and these openings occurred during quiet solar conditions. Joe has put together several charts that sum up his observations, and these can be seen in the July 2009 issue of *QST* in the "World above 50 MHz" column.

At the time of this writing (June 22nd), it appears that similar conditions for long-range DX on 6 meters will occur during the summer of 2009. The Japan to U.S. openings along with the transatlantic openings will be the most likely, along with some possible new paths occurring. The ARRL June VHF QSO Party had excellent sporadic-*E* openings for much of the U.S. both Saturday afternoon and Sunday morning. I did particularly well working many stations in Florida on both SSB and CW while running QRP portable from a hilltop location on Long Island. I even experienced a double-hop sporadic-*E* opening by working NP4A and HI3/LY3UM on CW around noon on Sunday.

In general, signals from multiple-hop sporadic-*E* events tend to be on the weaker side. Of course, some double-hop events can produce very loud signals, but in many cases of multiple-hop events, even when using three-element Yagi antennas and more, signals tend to be weaker and require careful listening. I believe the combination of better receiver and antenna combinations, along with better listening skills and the addition of internet spotting, may be why more of these events have been discovered in recent years.

Some of these events seem to be of significant duration as well. On the evening of June 21st, I observed a double-hop sporadic-*E* opening into the Caribbean. Some of the signals were fairly loud, yet some were consistently weak, similar to EME quality. It started for me with HI3TEJ at 5:43 PM, followed by J39BS at 5:52, and several others over the next three hours. The opening was still hanging in there 2 1/2 hours later when I worked NP3CW at 8:11 PM. It suggests that the two sporadic-*E* formations involved in this opening did not move significantly, although signal strengths of the Caribbean stations were changing during this time due to the non-uniformity of the formations.

So far observations have been encouraging that this may be a really terrific summer for 6 meters. My intention is to follow up with a summary report of subsequent events in late June and all of July in the next issue of *CQ VHF*.

By John Champa,* K8OCL

HSMM

Communicating Voice, Video, and Data with Amateur Radio

New Amateur Digital Video (ADV) and Revolutionary HSMM-MESH® at Ham-Com

Ham-Com is the largest amateur radio convention in Texas. Given the size of this state, that is certainly saying something. It is successfully organized every year by a fine team of individuals led by John Beadles, N5OOM, of Richardson, Texas (see <http://www.hamcom.org/> and <http://www.n5oom.org/hsmm/>).

This year was special for HSMM (High-Speed Multimedia) radio experimenters. Glenn Currie, KD5MFW, Alexandre Castellane, F5SFU, and I got two full hours during prime-time Saturday afternoon to demo all the new firmware and hardware developments. It was a standing-room-only audience and we all had a great time.

I was the first presenter, explaining the usual differences between WiFi (FCC Part 15) and HSMM (FCC Part 97) radios operating using spread-spectrum modulation. We discussed the three main reasons why HSMM radio experimentation was started by Paul Renaldo, W4RI, ARRL CTO (Chief Technology Officer):

1. Amateur radio, particularly EmComm (this was just after 9/11), needed some means of data transmission significantly faster than conventional packet radio. HSMM radio can send the entire *ARRL Handbook* in under one minute, so it certainly fits that requirement.

2. Our service definitely needs to better utilize the big VHF and UHF frequency allocations we have been granted. Even bands considered "busy" are largely limited to commuting rush-hour activities, contest weekends, weekly nets, or occasional band-opening phenomena.

3. All of our EmComm served agencies are extensive users of wireless technology, while radio amateurs, "the communications experts," know everything about radios except those which are the most popular in the world—WLAN transceivers and CDMA HTs! My beautiful wife Karen calls this a "time warp.... Hams use post WW II technology (AM, FM, SSB, RTTY, etc.), but seldom have any knowledge whatsoever regarding how the most common radios in the world operate!" Please don't misunderstand me. All the legacy modes are great fun to operate. I have used them all, and I still do everyday. However, let's not deceive ourselves about them being cutting-edge technology, nor the most popular two-way radio, nor certainly making us competition-grade communications experts.

To that list of these three rationales, many others would add a big fourth: We need to attract many more new and younger operators, if our service is to survive. Thus, we need to have modes such as "internet radios" (networked radios) that turn on the younger set.

We discussed the most frequent use of HSMM technology today—Field Day! Hardly any serious Field Day site is set up these days without some sort of intranet connection for common logging, etc. Also, a long-haul 2.4-GHz link is provided back to a ham's home for internet access, if only to order pizza or to ask the family to deliver more cold soda, etc.

The second most common use of HSMM radio is repeater linking. It is the usual stuff many of you are very familiar with already. However, another form of that application is starting to grow quickly. As more D-STAR repeaters are installed, they are finding prime building sites but experiencing difficulty in acquiring their required internet access.

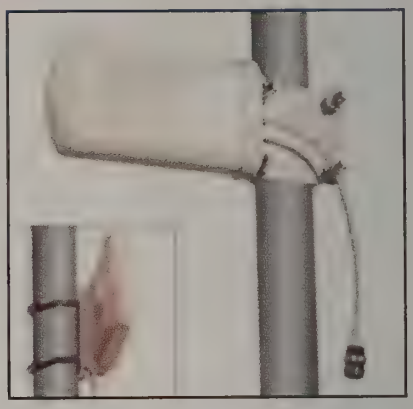

Photo A. My favorite personal pick for a new HSMM radio antenna this year is the ICOM Tri-Bander. In this photo the antenna is shown mounted in the vertical-polarization configuration. I recommend that it be reconfigured to horizontal polarization for the purpose of HSMM radio. (Photo courtesy of L-Com Global Connectivity, <http://www.l-com.com>)

Building owners are saying, "Sure you can have a nice free spot on our roof, but there is no way we will let you connect to our intranet to obtain internet access. Just forget that!"

Thus, HSMM radio provides a point-to-point to the nearest open internet access point.

Amateur Digital Video

At Ham-Com I explained the difference between ADV Amateur Digital Video) (which is internet-grade digital video using software coder-decoders over HSMM radio) and ATV (analog NTSC old, standard television). There is also DATV (new HDTV using hardware coders-decoders). OK, a no brainer, but give me a demo!

That is difficult in print, so for now, try this site: <http://www.youtube.com/watch?v=sb4rhP1LiC4>. If you can do streaming video on the internet you can

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Note: HSMM-MESH® is the registered trademark of Glenn R. Currie, KD5MFW; Richard E. Kirchhof, III, NG5V; Robert B. Morgan, WB5AOH; and David B. Rivenburg, AD5OO. The term HSMM-MESH® is the property of these gentlemen and may not be used without recognition.

Photo B. The ICOM 3-watt bi-directional amplifier (BDA) with Automatic Power Control (APC). (Photo courtesy of L-Com Global Connectivity)

do it on HSMM. It is just that simple. But remember, on the air our amateur radio content rules still apply. Don't worry about pop-ups (you should have a pop-up blocker) and background music as long as they are merely incidental to your traffic, but no business!

As we have recommended numerous times on these pages, all HSMM radio station computers/laptops must be equipped with the latest anti-virus/anti-spyware protection (free programs are available) and be kept current. Also, use a software firewall of some type. Most computers come with a firewall. Just make certain it is enabled so that no changes can be made to your computer without your specific authorization.

HSMM Antenna Pick of the Year

Excellent HSMM radio gear such as shown here is offered at reasonable prices and with good service by numerous distributors: FAB Corporation (http://www.fabcorp.com/home.php), L-Com Communications (http://www.l-com.com), and many others.

As for wireless routers such as the very popular Linksys WRT-54GL, try your local Goodwill store or similar used-electronics outlet. Why buy something new? You are going to hack into to it anyway, right? These popular WiFi WLAN 2.4-GHz transceivers are available for about $29.95 used. Stick to Linksys Models V 1, V2, V2.1, V3, and V4, as these are capable of the HSMM-MESH® crystal hack we will cover in a future issue that allows for some VFO action.

My favorite personal pick for a new HSMM radio antenna this year is the ICOM Tri-Bander (photo A). It is a log-periodic design that covers the 2.4-, 3.5-, and 5.8-GHz bands! Also, it comes with a nice radome for protection from environmental effects. The manufacturer rates it at better than 6 dBi forward gain.

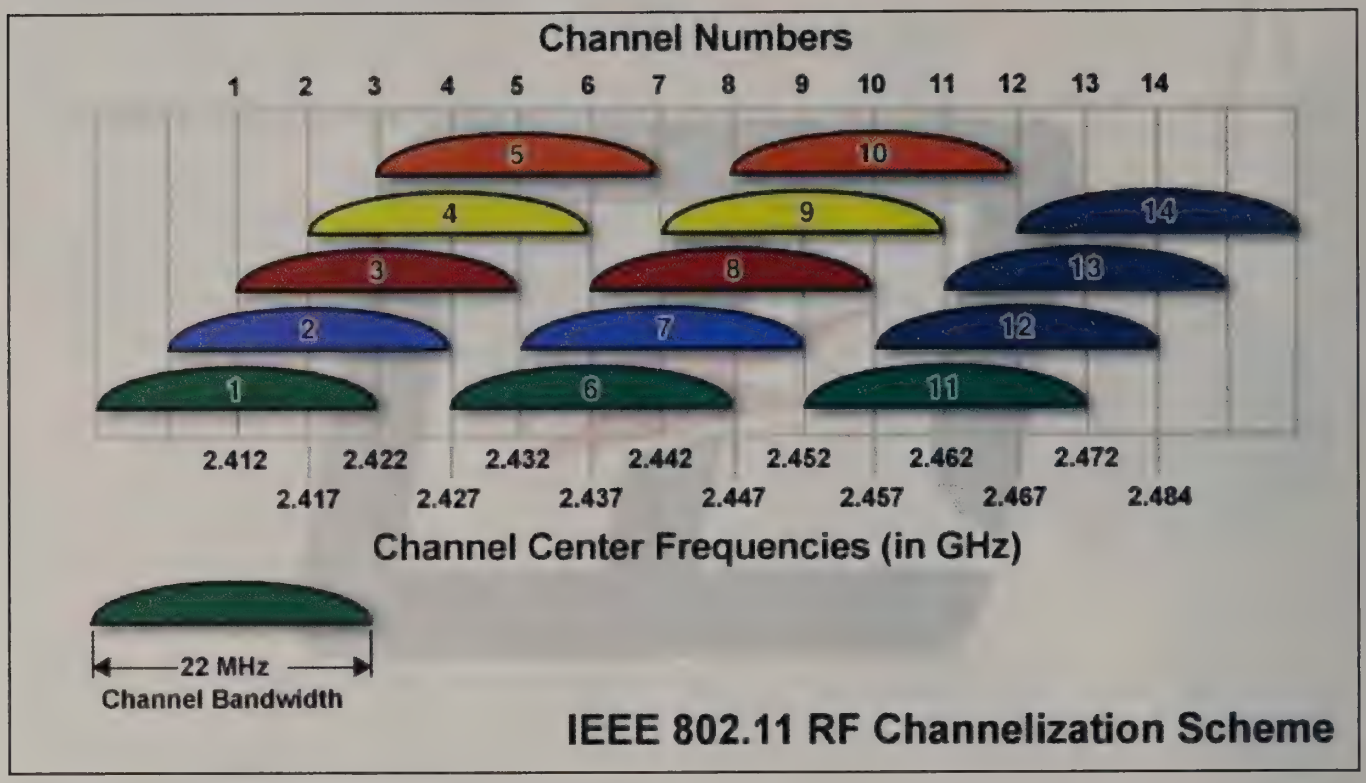

Figure 1. Channel center frequency chart. Some commercial Part 15 service providers use horizontal antennas for the same reason we radio amateurs often do. In that case, if you are operating in the same areas, you should coordinate closely with them regarding specific channel utilization. (Chart courtesy of L-Com Global Connectivity)

In the photo the antenna is shown mounted in the vertical-polarization configuration. I recommend that it be reconfigured to horizontal polarization for the purpose of HSMM radio. Not only does horizontal polarization seem to perform better than vertical polarization at these frequencies, but also using horizontal polarization will provide some slight isolation from the huge number of unlicensed Part 15 WiFi stations, the vast majority of which use vertical polarization. The only issue with using horizontal polarization is working HSMM radio mobile stations, most of which use phased collinear, high-gain, vertical, magnetic-mount antennas. Perhaps for some of us the M2 S-Band Stacked Horn, Sector Antenna (http://www.m2inc.com/com/SBNDHORNFLY2.pdf), or something similar homebrewed, may be a solution.

Also, some commercial Part 15 service providers use horizontal antennas for the same reason we radio amateurs often do. In that case, if you are operating in the same areas, you should coordinate closely with them regarding specific channel utilization. Yes, hams have the legal priority, but we always should try to be good neighbors. For example, at one location the local HSMM radio group coordinated with the Part 15 wireless commercial internet service provider (WISP) such that in the areas where they were both operating, the HSMM group used Channel 1 while the unlicensed commercial group used Channel 3. True, these are not completely non-overlapping channel assignments, but at least it prevented a portion of the possible destructive interference and allowed both groups to operate effectively in the same area. It certainly beats the usual college campus situation in which every single channel is in use! See the accompanying channel center frequency chart, figure 1, for additional details.

My personal favorite for new gear is another item also manufactured by ICOM: It is a 3-watt bi-directional amplifier (BDA) with Automatic Power Control (APC); see photo B. Now I know that the ARRL HSMM Working Group received notice from the FCC via the League's General Counsel that APC is no longer a requirement for hams under the Part 97 Spread Spectrum Rules. The FCC considers APC for hams—who often build their own equipment, including BDAs—"technologically impractical." However, this ICOM BDA has such a feature, which is supposed to provide some advantages. Besides lower power consumption, I have not figured out yet what those are. Perhaps an enlightened reader can let us know how a BDA works better with APC.

WARNING! It is illegal for you to connect this ICOM equipment to your WiFi Wireless Local Area Network (WLAN) router unless you are a licensed radio amateur under FCC Part 97 Regulations. If you are an unlicensed FCC Part 15 station and you connect this equipment to your WiFi WLAN you are subject to fines, confiscation, and imprisonment. Distributors of this equipment also have the right and responsibility to demand a copy of your FCC Radio Amateur license prior to any sale of this equipment to you. *You must be a licensed radio amateur to use this gear!*

More importantly, shocking new revolutionary developments in HSMM-MESH® networking make even reasonably priced BDAs such as this ICOM model less often necessary for most HSMM radio hams. See more details on HSMM-MESH® later.

It is somewhat similar to the classic question: "Do I need an amplifier?" The answer is if you have a good propagation path, you probably do *not* need a BDA. This reminds me of my

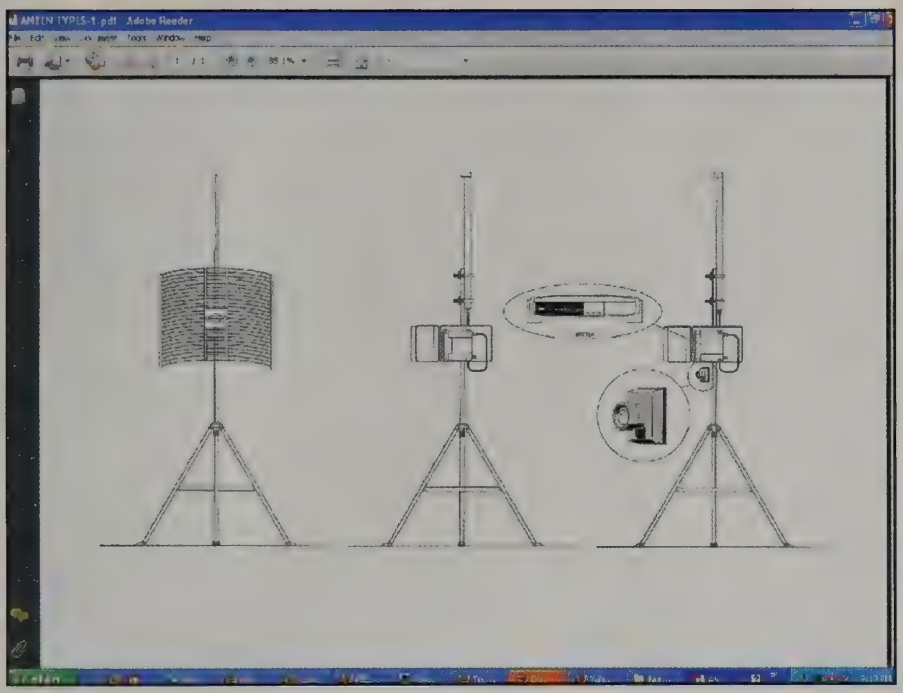

Figure 2. How a typical HSMM-MESH® node is designed. The nodes are fully automatic and self-powered. (© 2009, Glenn R. Currie, KD5MFW)

Photo C. This is typical stand-alone, omni-directional, fully automatic HSMM-MESH® node. (Photo credit David B. Rivenburg, AD5OO)

DXpedition to Zimbabwe in southern Africa as Z2/ K8OCL. I tried to check into a stateside HF DX net. They all were running big antenna arrays and powerful linear amplifiers. They all apparently could hear one another. I could easily and loudly hear nearly all of them. However, try as I might, with my 100-watt SSB rig and my dipole antenna, they could not hear me!

What is HSMM-MESH® Networking?

Simply put, mesh networking is a form of digital communications that is designed to route data, voice, and instructions between nodes. This routing is accomplished by continuous connections and reconfiguration around broken or blocked paths by "hopping" from node to node until the destination is reached. Thus, HSMM-MESH® networking is using HSMM in a mesh network.

Glenn Currie, KD5MFW (kd5mfw@arrl.net) with the Austin HSMM Special Interest Group (Austin HSMM SIG) and the Roadrunners Microwave Group (RMG) was the second presenter at HamCom 2009. The presentation was dedicated to Glenn's fine father, Job H. Currie, who recently passed away. Glenn's session was a blockbuster.

Glenn immediately gave credit to all the fine organizations, and their members, that are helping with the implementation and city-wide deployment of HSMM-MESH® networked radios:

- The Austin Amateur Radio Club (http://www.austinhams.org/)
- The Roadrunner Microwave Group (http://www.k5rmg.org/)
- The North Texas Microwave Society (http://www.ntms.org/)
- The Austin HSMM Special Interest Group (Travis County ARES SIG)
- The Travis County ARES (http://www.your-website-in-24-hours.com/travishams/tcares.org/index.php?option=com_content&task=view&id=17&Itemid=1)
- Williamson County ARES (http://www.wc-ares.org/)

Figure 2, the design, and photo C show a typical HSMM-MESH® node. The nodes are fully automatic and self-powered. Any EmComm ham unfamiliar with HSMM or microwave radio can transport the node to a designated site and simply turn it on. The rest is automatic! The node connects to the HSMM-MESH© network and starts passing high-speed data traffic within a few seconds.

The Austin HSMM Special Interest Group has developed hardware and software changes to make use of inexpensive 802.11 wireless computer networking radios but under Part 97 FCC rules. The major changes include:

- Range extended to 10–15 miles with good line of sight.
- Automatic address negotiation so radios link automatically with no user intervention within 5 seconds of coming into RF range of each other. We use Optimum Link State Routing (OLSR). See this link for more info: <www.olsr.org>.
- The RF section of the common Linksys WRT54GL Wireless Router has been modified so that only like-modified radios can see it. They are invisible to all Standard 802.11 radio devices.
- There are many new features in progress, but HSMM-MESH® has

reached a point where it is being deployed to augment existing Amateur Radio Communications Healthcare Emergency Services (ARCHES) radio stations in the hospitals, Emergency Operation Centers (EOC), and the Red Cross in the Austin, TX area (photo D).

Background

Quote from the ARRL website:

"The Amateur Radio bands above 50 MHz can support computer-to-computer communications at speeds high enough to support multimedia applications.

"Multimedia in this case refers to voice, data and image communications.

"One approach that has been extensively explored is an adaptation of IEEE 802.11 technologies, particularly 802.11b operating in the 2400-2450 MHz band, known as the *Hinternet*.

"Also under the HSMM umbrella has been an orthogonal frequency division multiplex (OFDM) system developed by John Stephenson, KD6OZH, and tested on the 6-m band."

Photo D. This is Robert "Bob" Morgan, WB5AOH, mounting HSMM antennas on the Austin Texas Red Cross Tower, which is part of the AARC club station, W5KA. (Photo credit David, AD5OO)

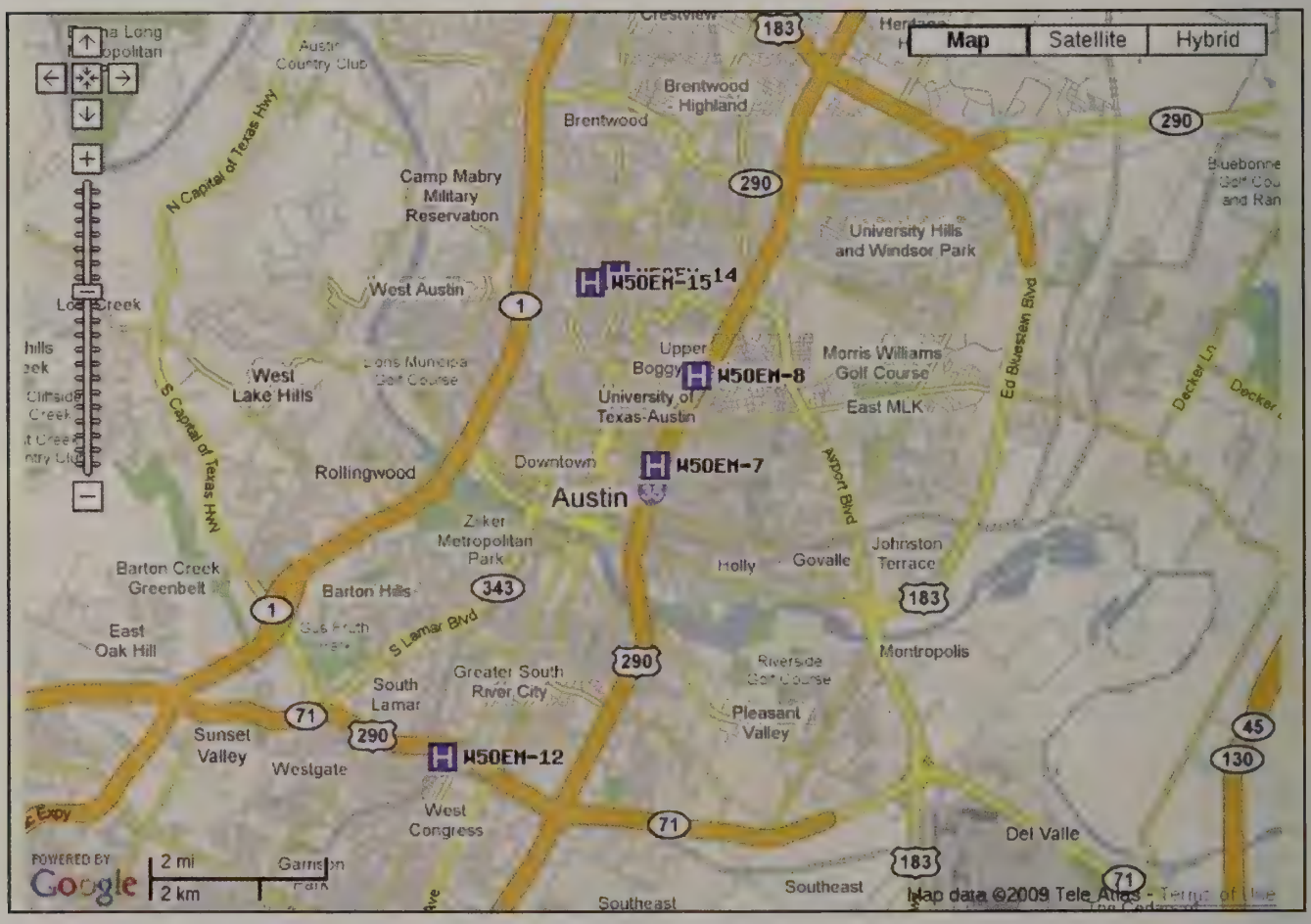

Figure 3. This map shows the hospitals that are online and help new operators find hospitals via internet maps. Go to <http://findu.com/> and do a wild-card search for stations W5OEM- and you will see the hospital stations.*

(Editor's note: We would also add D-STAR 1.2-GHz HSMM radio to this list.)

Figure 3 is a map of all the ARCHES node equipped hospitals in Austin, TX. The highly successful ARCHES 2m/70cm voice and packet radios at nine Austin area hospitals provide key patient data to the City of Austin Emergency Operations Center during significant incidents even if normal communications are unavailable.

All ARCHES stations beacon on APRS every 20 minutes. If one of the monitor computers does not hear from a station for an hour, the operator in charge is paged, with an automated message that the automatic beacon has gone out at the hospital.

During every activation, patient data and other traffic passed more quickly and accurately than all other techniques tested during the activations. The ARCHES program has been so successful that hams have been asked to expand the system to approximately 40 additional area hospitals and clinics in central Texas! Here is the crunch! During activations with just nine area hospitals, the EOC, and several portable "jump kits," all packet frequencies were more than full, leading to many collisions of packets. With 40 or more packet stations in the area, passing packet data could slow to a crawl due to packet collisions.

The stations could only transfer data at 1200 baud, at best. Attempts at using 9600 baud showed that common radios do not pass 9600-baud data well. They distort the data so badly that many resends are needed to get data through. The effective data rate seldom exceeds 1200 baud.

The obvious solution was to use an HSMM radio technique of adapting inexpensive Part 15 802.11 radios repurposed to use under Part 97. The question was could the necessary links be achieved in the Austin area. The answer: AD5OO, NG5V, and KD5MFW achieved a 10-mile point-to-point link across downtown Austin using only 35 mw (photo E)! Figure 4 is a sample map of the open routes that were found on the 2.4 GHz band.

Photo F shows a North Austin Mobile HSMM radio test site. Note the ubiquitous MFJ-1800 antenna. They work extremely well but must be protected by a thin plastic radome when used outside in permanent installations.

The secret of HSMM-MESH® success is in the use of OLSR (Optimal Links State Routing). OLSR is state-of-the-art mobile networking software. Andreas Tonnesen wrote the version of OLSR software being used for his Master's thesis. He wrote the code and made it to run on the Linksys WRT54G Wireless router. It is written on top of Open-WRT firmware for several reasons: Andreas suggested keeping track of one- and two-hop neighbor mesh nodes, not *all* mesh nodes in the network. The trick is to

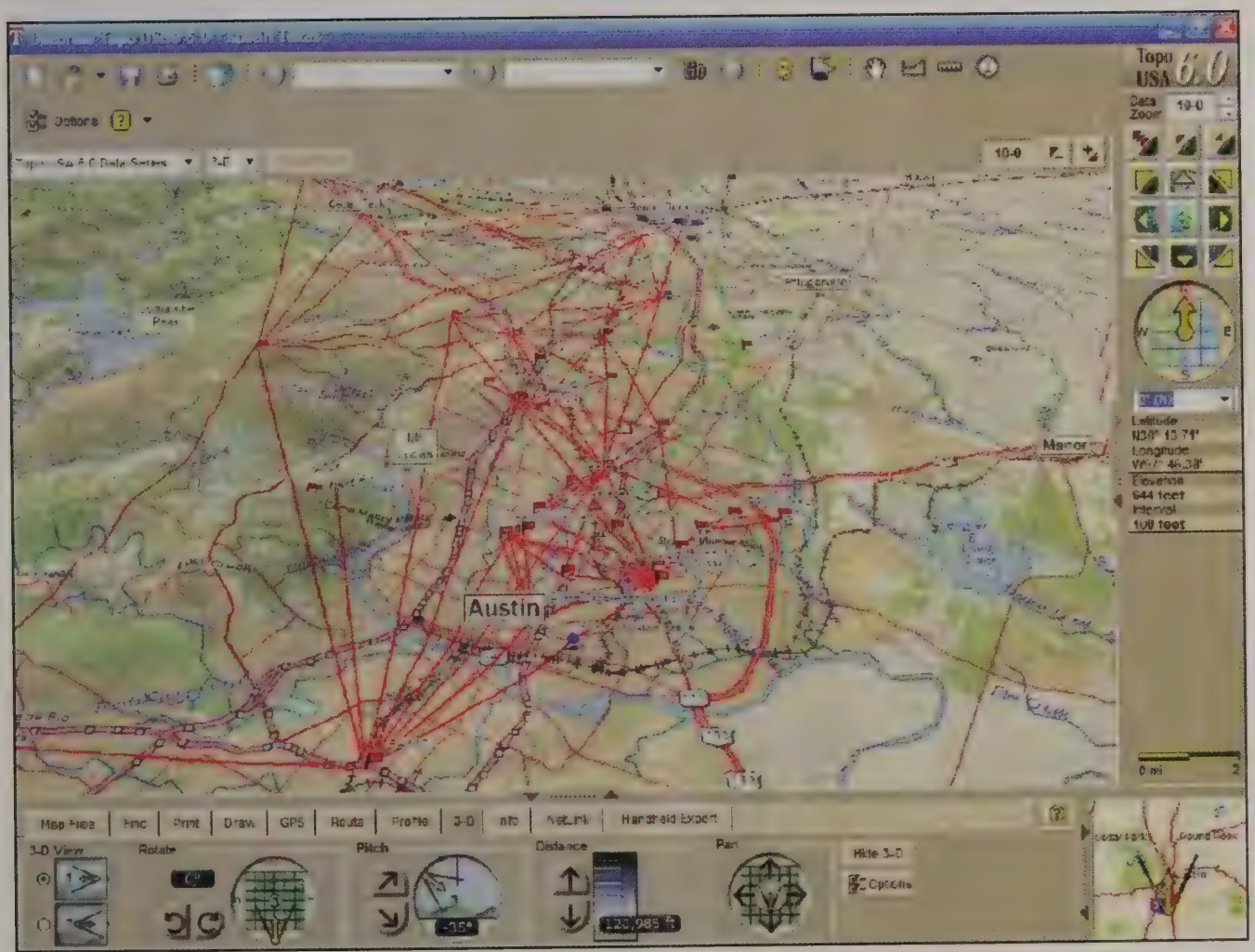

Figure 4. This is a sample of Glenn's use of DeLorme Topo USA© to plot potential microwave routes for HSMM-MESH® in the Austin area.

Photo E. Shooting to AD5OO on the north side of town over the heavily populated University of Texas, Austin campus area showing 35 mw can go 10 miles over thousands of access points and microwave ovens in between. This is an HSMM radio test site at the South Austin Medical Center. (Photo credit Glenn Currie, KD5MFW)

update the routing table list about every 2 seconds. This allows nodes to come and go as conditions allow. They will be linked and passing data in 5 seconds when in RF range. Absolutely no user interaction is needed! If a link is lost, data is automatically rerouted through other nodes, again with no user interaction.

HSMM "VFO" Crystal, or the "Slide-Band" Radio Mod

Crystal frequency change makes it impossible for standard 802.11 devices to connect with an HSMM-MESH® "slide band" radio network. The tests showed that by making a simple 59-cent crystal change the HSMM signals could be moved to between IEEE Channels 2–3.

Figure 5 is from Wi-SPY® by MetaGeek (http://metageek. com). The yellow shaded area shows the official 802.11 Channel 2 center. The red shaded section shows the official 803.11 Channel 11. Glenn had one crystal-modified Linksys WRT54G and one unmodified Linksys WRT54G. He then directed the software for both of them to go to Channel 11.

The CPU clock and ethernet clocks are totally different from the radio crystal, so both units "think" they are on Channel 11. Only the crystal-modified "slide band" unit is somewhere between Channels 2 and 3 as shown by the green and blue accumulated readings. Both units were tested for about 3 hours for frequency stability, etc.

The Wi-SPY spectrum analyzer cannot follow the slide band as it goes much lower in frequency out of the ISM band. Glenn put it on Channel 11 so he could see the slide band with this inexpensive spectrum analyzer. The shift was right on the money of what the crystal-modification calculations predicted. This frequency shift makes the HSMM-MESH® signal completely invisible to Part 15 stations, and even to WiFi search engines such as NetStumbler (http://www.netstumbler.com/). The signal is totally WiFi stealth! The only way the signal is detected is by using a spectrum analyzer.

Wow! Now we have it: A complete ham radio (Part 97) inexpensive spread-spectrum transceiver on 2.4 GHz with different frequency(s), different antennas, and different firmware. The Hinternet has arrived!

ADV Demonstration

Alexandre Castellane, F5SFU, conducted the highlight of the entire HamCom 2009 HSMM 2-hour presentation with his Amateur Digital Video (ADV) live demonstration. Alexandre had prepositioned four HSMM-MESH® battery-powered/fully-automatic nodes throughout the huge Plano Convention Center. Using free streaming video software and an inexpensive web cam, Alexandre was able to walk through the entire complex while we watched his progress in the meeting room via this mini-Hinternet arrangement. The mesh nodes functioned perfectly. Each time Alexandre walked out of range of one node with its simple rubber-duck antenna, his streaming video traffic would

Photo F. David, AD5OO/HSMM mobile with his trusty MFJ-1800 antenna. (Photo credit AD5OO)

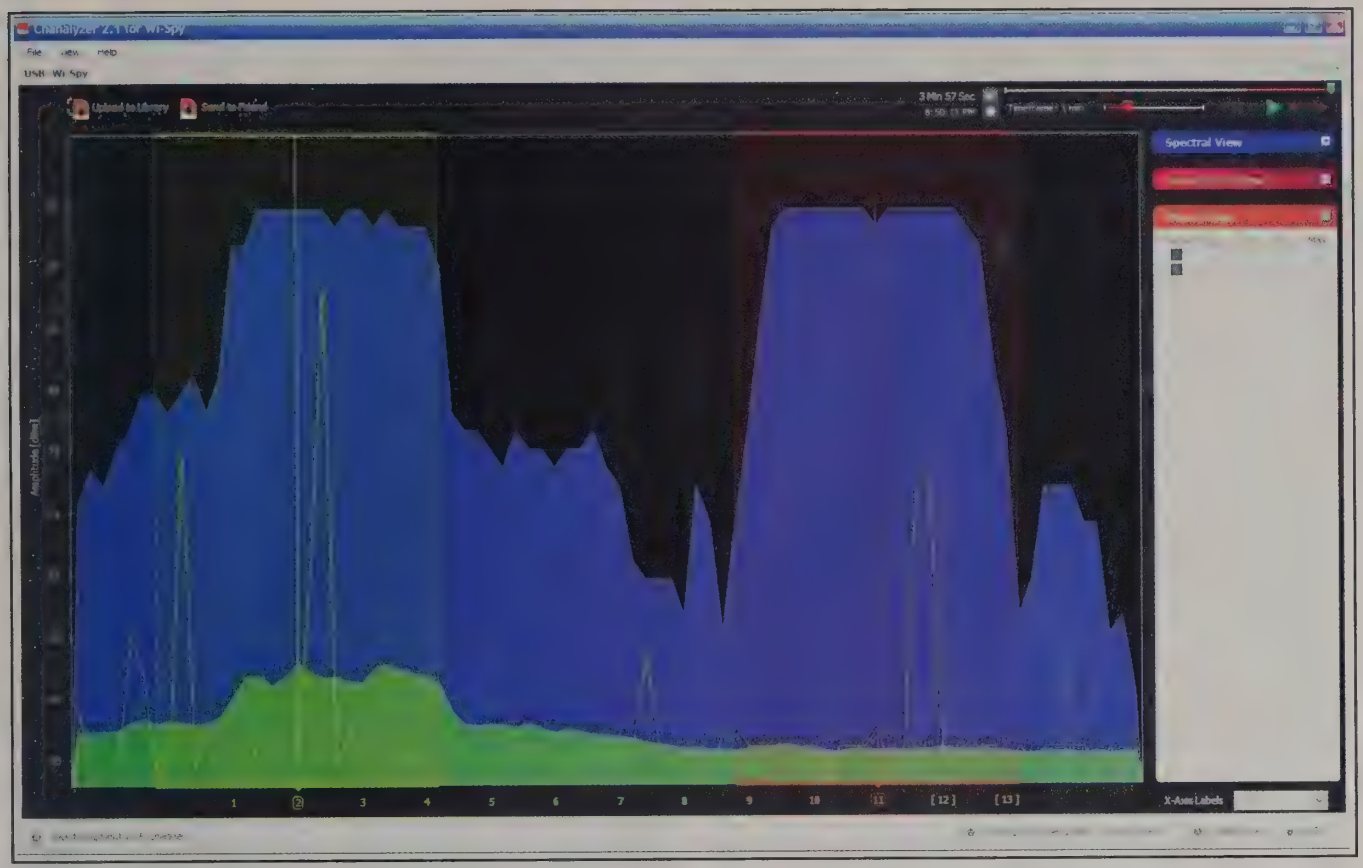

Figure 5. This spectrum analysis is from Wi-SPY® by MetaGeek (http://metageek. com). The yellow shaded area shows the official 802.11 Channel 2 center. The red shaded section shows the official 803.11 Channel 11.

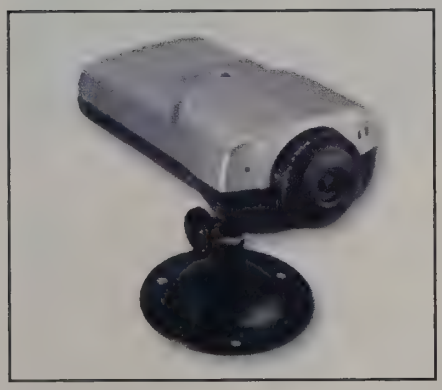

Photo G. A typical inexpensive web cam purchased used for $39.95. (Photo credit Glenn, KD5MFW)

automatically be relayed to the next node. It was stunning to watch!

Photo G shows a typical inexpensive web cam purchased used for $39.95. John, K8OCL, uses one he purchased new at the Dayton Hamvention® that is even smaller and sold for even less. Couple this with some free video streaming software such as Microsoft NetMeeting® and you are on ADV! Hope to see you soon!

Until next time, feel free to write with your questions and comments to: <k8ocl @arrl.net> or <kd5mfw@arrl.net>.

73, John, K8OCL

References

HSMM references in order of preference for getting started. All of these are available from the ARRL Book Store: <http://www.arrl.org/catalog/?category=Digital+Communications&words=>.

ARRL's VHF Digital Handbook, by Steve Ford, WB8IMY. Without complicated "owner's manual" jargon this book presents the material through a unique how-to approach and friendly, conversational style. Readers will understand how to setup and operate their equipment and software, and make the best use of their VHF digital station. Contents include: Packet Radio Fundamentals, APRS, D-STAR, High Speed Multimedia, Digital Meteor Scatter and Moonbounce, Technical Descriptions, plus digital applications in public service and emergency communications.

Building Wireless Community Networks, 2nd Edition, by Rob Flickenger. This book is about getting people online using wireless network technology. The 802.11b standard (also known as WiFi) makes it possible to network towns, schools, neighborhoods, small business, and almost any kind of organization. The first edition of this book helped thousands of people engage in community networking activities. This revised and expanded edition adds coverage on new network monitoring tools and techniques, regulations affecting wireless deployment, and IP network administration, including DNS and IP Tunneling. (182 pages. Second edition, © 2003, published by O'Reilly & Associates, Inc.)

802.11 Wireless Networks: The Definitive Guide, by Matthew S. Gast. Creating and administering wireless networks. Wireless networks are also more flexible, faster and easier for you to use, and more affordable to deploy and maintain. The de facto standard for wireless networking is the 802.11 protocols, which include Wi-Fi (the wireless standard known as 802.11b) and its faster cousin, 802.11g. But it's wise to be familiar with both the capabilities and risks associated with the 802.11 protocols. This book the perfect place to start and is designed with the system administrator or serious home user in mind. It's a no-nonsense guide for setting up 802.11 on Windows and Linux. Among the wide range of topics covered are discussions on: deployment considerations, network monitoring and performance tuning, wireless security issues, how to use and select access points, network monitoring essentials, wireless card configuration, and security issues unique to wireless networks.

By Joe Moell,* KØOV

HOMING IN

Radio Direction Finding for Fun and Public Service

Championship Foxhunting Brings the World to Boston

Ten-thousand years ago the area south of today's Boston was the home of Algonquian natives called the Massachusett, meaning "people of the great hills." That's how the state got its name. Nowadays, those hills are a major source of recreation, with skiing every winter followed by hiking, fishing, camping, and swimming in the warm months. This year, for the first time, they were the site of a multi-nation RDF (radio-direction-finding) contest.

International-rules on-foot RDF contesting (also called foxtailing), radio-orienteering, and ARDF, came to the USA 18 years ago. In the early years, the only stateside activity was on the West Coast. The first major event east of the Mississippi didn't take place until 2002. Ideal radio-orienteering locations exist in New England, but only one person from that part of the country became an ARDF regular. He is Vadim Afonkin, ex-UZ3AYT, of Boston.

Vadim learned the sport as a youth in his native Russia. Indeed, he learned it well, because beginning with his first USA championships in 2003, he has taken overall top honors almost every year. Last fall, he volunteered to put on the 2009 championships for USA and IARU (International Amateur Radio Union) Region 2 (North and South America).

A Mostly One-Man Show

Normally it takes a club or a large committee to put on an ARDF event of this size and scope. However, Vadim, now KB1RLI, did almost all of the leg work himself. He got excellent cooperation from the NEOC (New England Orienteering Club) in arranging for the site and getting detailed orienteering maps. In return, he taught ARDF to interested NEOC members—more about that later.

With diplomatic help from ARRL Headquarters, Vadim invited ARDF experts from eastern Europe to come to America to take part. He found discounted lodging for participants and extra RDF gear to loan to beginners. Most important, he set two world-class ARDF courses, one on 2 meters and the other on 80 meters. "I want to take our USA team up to the next level," he told me, "so we all will do better at future world championships."

Vadim and I discussed two possible forest locations for the contests. One was in the western part of the state, a lengthy drive from Boston. The other was Blue Hills Reservation, the former home of the Massachusett natives, just 10 miles south of the Cradle of Liberty. These 7000 acres are the largest open space within a major metropolitan area. Most of the woods are runable, if you don't mind trails that go up and down 300-foot hills.

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Every five minutes, up to four competitors in different age/gender categories are started as fox #1 begins transmitting. In the 2-meter starting corridor are Addison Bosley from Kentucky, the youngest competitor at this year's championships, and Bill Smathers, KG6HXX, a long-time radio-orienteer from California who is now in M50 category. (All photos by Joe Moell, KØOV)

The Blue Hills Reservation is away from the expensive downtown area, yet it's easily reached by commuter rail. My only concern about this site was that high levels of urban ham activity and other RF sources might adversely affect 2-meter ARDF receivers, especially older European models which have wide intermediate-frequency stages. As it turned out, these worries were mostly unfounded[1] and Blue Hills was an ideal location.

Radio-orienteering championships in the USA always attract interest around the world, despite the difficulty of getting visas from some countries to visit the states. For a while, it appeared that foxtailers from China and Mongolia would attend, but that didn't work out. The final list of competitors included representatives from Australia, Canada, Germany, Japan, Russia, Sweden, the United Kingdom, and the Ukraine.

Among the starters were eight Massachusetts residents, none of whom had been to a large ARDF event before. Five of them

At Friday's equipment checkout session in Breakheart Reservation, Bob Frey, WA6EZV, shows his home-built 2-meter ARDF receiver to the two Japanese participants, Kentaro Kurogi and Masahiko Mimura.

Russian ARDF champion Igor Kekin didn't look winded as he punched in at the finish line of the 2-meter foxhunt. Even though he is over age 50, he competed against runners in their 20s and found all five transmitters in just under two hours to win a bronze medal. ⟶

were members of the NEOC. Their experience with map-and-compass navigation gave them a good start in the sport. Beginning in March, Vadim helped them achieve RDF skills by putting on practices and "dry runs" in sites such as Franklin Park.

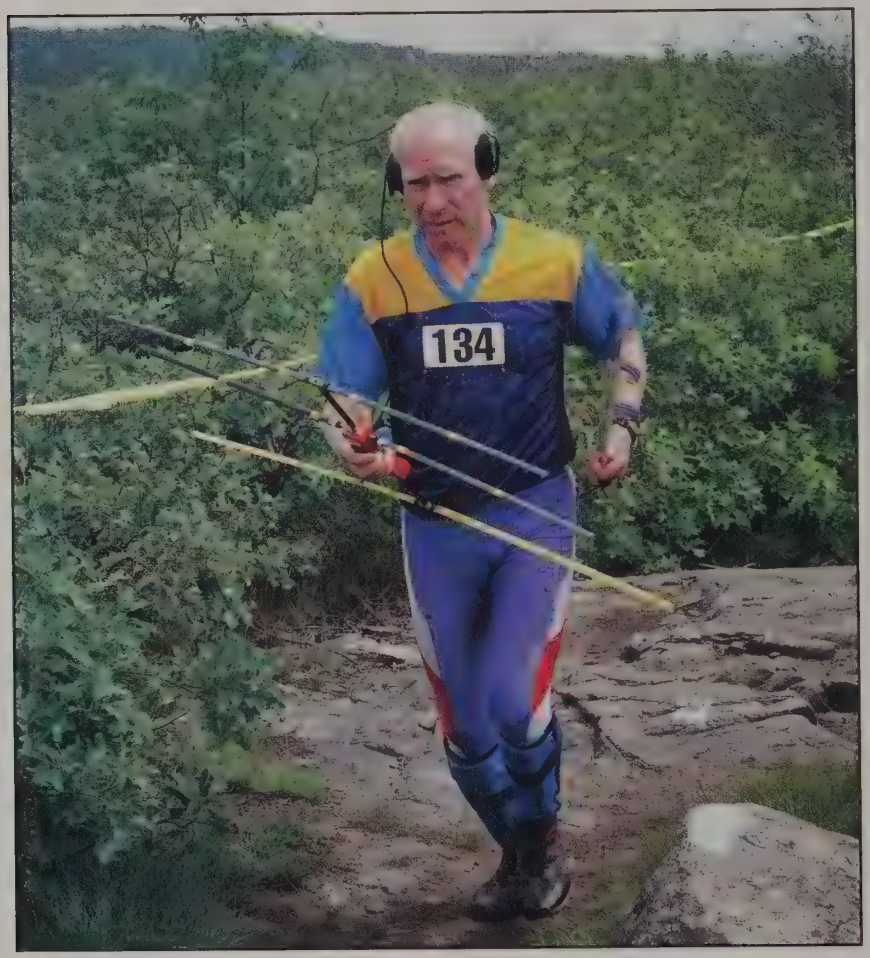
In the three decades since international rules for ARDF were first set down in the nations of Europe, the number of official age/gender divisions has grown from three to nine. Males between 20 and 39 years of age must search for all five transmitters. Those in the two categories covering ages from 40 through 59 need find only four, and those 60 and over need go for only three.[2] However, men of any age can sign up for the M21 category, putting them up against men in their 20s and 30s and having to seek all five transmitters.

Because it was on a hilltop, many competitors stopped at the end of the 2-meter corridor to plot bearings on all the transmitters. David Williams, M3WDD, of the UK went on to win gold in the category for men over age 40 by finding four foxes in less than an hour and a half. The GPS device on his left wrist does not help him with navigation, but it records his route for later analysis.

Up and Down

NEOC's map of the western section of Blue Hills encompasses almost 2000 acres. All of it was used for each of the two transmitter hunts. The finish areas for

Organizer and host Vadim Afonkin, KB1RLI (at left), congratulates Boston orienteer Leszek Lechowicz, NI1L, on his success in his first ARDF championships. Leszek was fourth in the M40 category on 2 meters and second on 80 meters.



Nikolay Ivanchihin, UR8UA, runs up the 2-meter starting corridor. This amazing Ukrainian competed in the same category as 20- to 40-year-olds and was over 15 minutes faster than any of them on both bands.

2 meters on Saturday and 80 meters on Sunday were close to the beaches of Houghton Pond in the south. The starts for the two days were at opposite ends. Knowing that 2-meter signals can be blocked and reflected by terrain features and wanting to make sure that all of them could be heard, Vadim chose the top of Buck Hill for the start of that event. At 480 feet elevation, it is the highest point in the eastern half of the hunt area.

Vadim's world-class 2-meter course was 3.5 miles point-to-point from start to each of the five transmitters in optimum order and then to the finish. Actual routes of the competitors were considerably greater than that, of course. Four of the foxes were near the tops of Burnt Hill, Tucker Hill, Houghton Hill, and Hemenway Hill. The fifth was on the steep eastern slope of Great Blue Hill near Wildcat Notch.

The undisputed "Best in Show" for 2009 was 58-year-old Nikolay Ivanchihin, UR8UA, of the Ukraine. He chose the five-fox M21 category and easily defeated men half his age and younger. Impressive performances on 2 meters in M21 were turned in by Matthias Kuehlewein, DL3SDO; Igor Kekin; Jay Thompson, W6JAY; and Ian Smith, but UR8UA beat them all by 27 minutes or more.

What is Nikolay's secret? It isn't his equipment, which for 2 meters is a standard Ukrainian ARDF receiver built into the boom of a three-element Yagi. According to David Williams, M3WDD, of the UK, Nikolay has perfected the ability to predict the likely hidden transmitter locations and to continuously estimate his distance from each one by listening to the signal.[3]

Many hunters closely followed their bearings and navigated directly toward each fox in what they judged to be the optimum order. Going cross-country slowed them down, as they had to go over hills and through heavy vegetation. By contrast, Nikolay and some other experts made good guesses about the fox locations, and then mentally plotted fast courses to each using the trails. They would continue on the trail until the signal was close and directly to the side, and then dive into the woods to punch in at the transmitter.

David's performance was outstanding, as well. M3WDD was the runaway leader in the four-fox M40 category both days. He was more than an hour faster than second place on 2 meters. Two weeks before,

he had won the 2-meter hunt at the British ARDF Championships in Shropshire, England.

At last year's World Champions near Seoul Korea, UR8UA took fifth place on 2 meters in the M50 category. This was the category in which George Neal, KF6YKN, was third, making him the second Team USA member to bring home a medal from a World Championship event.[4] On the podium with George that day was Igor Kekin of Russia, who won the gold in that category. KF6YKN couldn't be in Boston this year, but Igor came as a visitor. He chose to run in M21 and took third place on 2 meters behind UR8UA and DL3SDO.

At every USA championships there is friendly rivalry between the OH-KY-IN (Ohio, Kentucky, and Indiana) group in the Cincinnati area and the foxtailers from California to see who will get the most medals. This year, it looked like the battle ended in a draw with one of each color medal won by each group. For California, Bob Cooley, KF6VSE, took gold in M60 on 80 meters and bronze on 2 meters. Jay Hennigan, WB6RDV, got silver in M50 on 80 meters. For the Cincinnati group, Dick Arnett, WB4SUV, captured gold In M60 on 2 meters, Matthew Robbins, AA9YH, picked up silver in M40 on 2 meters, and Bob Frey, WA6EZV, took home bronze in M60 on 80 meters.

But wait, there was a new team member from OH-KY-IN. Addison Bosley of Erlanger, Kentucky is the grandson of Dick Arnett. At age 11, he was the youngest competitor at these championships. Addison earned gold medals in the M19 category on both bands. Congratulations, Addison!

Also performing well as a group were the new hunters from Massachusetts. Lori Huberman[5] won gold in W21 category on both bands. Brendan Shields was awarded bronze in M21 on 80 meters. Leszek Lechowicz, NI1L, received silver in M40 category on 80 meters. The best group of all in the medal count comprised the visitors from abroad. Seven gold, seven silver, and two bronze medals went into suitcases for overseas flights home.

Complete results and many more photos are on my "Homing In" website at <www.homingin.com>.

As always, first-aid expert April Moell, WA6OPS, was ready for any medical problems. This year she had help from Pavel Nelyubin, a cardiac nurse at Brigham and Women's Hospital in Boston. The most serious injury was to Valeri Georgiev of Montreal, who sprained his ankle and had to drop out of the championships after finding one 2-meter transmitter.

Hats off to KB1RLI for giving a jumpstart to ARDF in New England. Judging by the enthusiasm of the East Coast newcomers in attendance, interest in the sport has risen to a new high. However, Vadim can't keep the momentum going by himself. It's time for others to step forward and help arrange local events with publicity sent to all the nearby ham clubs. A session in New England during every warm-weather month would be ideal. Vadim will appreciate your support, too, because he needs to train so that he can be in the running for membership in Team USA 2010.

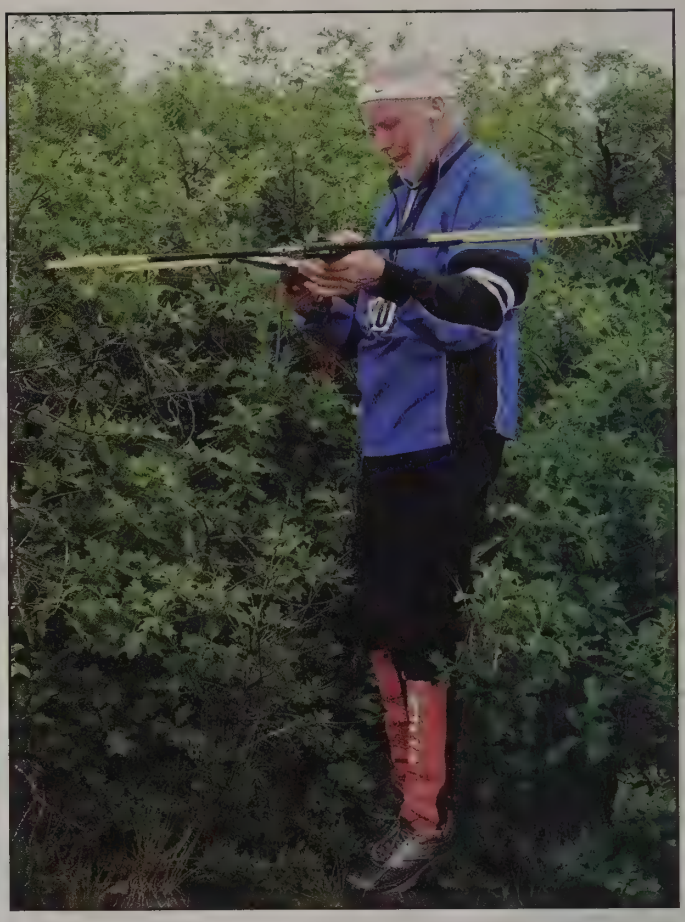
Several attendees at Blue Hills expressed interest in hosting next year's USA Championships in their localities. The 2010 championships must take place no later than mid-June so that Team USA can be selected for the Fifteenth World Championships in Croatia. If you like the idea of having dozens of enthusiastic hams and would-be hams coming to your home town to hunt radio foxes in the woods, see the article on my website about championships hosting[6] and contact me to discuss it.

T-Hunters and FCC Together Again

In previous columns, I have given examples of cooperation between the Los Angeles FCC office and hams in ARRL's Amateur Auxiliary. When Catherine Deaton retired as head of that FCC branch and Riley Hollingsworth stepped down from his enforcement post in Washington, there was concern that things would never be the same again. Indeed, they weren't for a while, with the Los Angles FCC staff being managed by the Denver office and a drop-off in emphasis on response to amateur radio matters. In the fall of 2008, FCC headquarters instructed the field offices that their highest priority was to help consumers with the transition to digital television. Staffers were assigned to give presentations at senior residences and to other consumer groups, leaving them little time for anything else.

Now Laura Smith has taken over ham radio enforcement matters in Washington. A newly appointed District Director, Nader Haghighat, is running the Los Angeles office. The DTV transition is

Ten minutes before their start times, competitors clear their electronic scoring "sticks" and receive their orienteering maps. Mark Diggins, VK3MD, is marking the start and finish locations on his map. He is Australian, but is presently working and living in the Boston area with his family.



Veteran radio-orienteer Per-Axel Nordwaeger, SMØBGU, was course-setter for the 1994 ARDF World Championships in Sweden. Even though he is now over 70 years old, he continues to be a regular competitor. In this first trip for him to the USA for ARDF, he went up against competitors in their early 60s and took home two silver medals.

complete and amateur radio again has visibility in the enforcement branch. For example, there was rapid response in May when the Orange Section Amateur Auxiliary presented the case of the concrete communicators.

In late April, hams in central and northern Orange County began hearing conversations on 146.025 MHz, the output of K6SOA/R, which is owned by SOARA, the South Orange Amateur Radio Association. The transmissions were clearly for business and appeared to be related to construction work. SOARA has regular hidden transmitter hunts, so some members were already equipped to go into action to find the source. Two of them, Richard Saunders, K6RBS, and Richard Clark, N6UZS, reported strong signals in the cities of Orange and Costa Mesa. However, the strength and direction of bearings were not the same from one day to the next.

Transmitter hunters in the Amateur Auxiliary soon joined in. The search wasn't simple, because the activity wasn't daily and it was sporadic on the days when it occurred. Next came reports of strong signals in Anaheim and Yorba Linda. From the sometimes-salty conversations, T-hunters concluded that they were listening to the handie-talkies of a concrete supplier at various job sites.

On May 21, one of the Auxiliary members[7] hit pay dirt at a construction site of the Diemer Filtration Plant in Yorba Linda. Photos and recordings were sent to the FCC, and within a week the interference was gone. The concrete supply firm had obtained its handie-talkies from a commercial two-ray radio supplier, which had mistakenly programmed them to transmit and receive on 146.025 MHz instead of 156.025 MHz. With no frequency readout and with tone squelch operational in their receivers, the concrete workers could not hear the SOARA repeater and had no idea that they were using an amateur radio frequency.

For FCC field engineers, this was a simple case because all they had to do was verify the information provided by the Amateur Auxiliary. It certainly pales in comparison to the work that office had to do on a recent non-amateur matter. According to the FCC Notice of Liability issued May 14, the first complaint came in on February 25. Somebody was deliberately interfering with maintenance and security two-way radios at The Oaks Shopping Center in Thousand Oaks, about 25 miles west of downtown Los Angeles. The perpetrator was harassing the employees by voice and by sending strong pulsating signals on the security repeater input frequency, rendering it useless.

Using one of the agency's mobile direction-finding vehicles, an engineer from the FCC office found the source of the pulsating signals on March 5 at a secure communications building on Oat Mountain, 19 miles northeast of the mall. The agent also discovered a beam antenna for the security frequency pointing toward Thousand Oaks.

The next day, the FCC collaborated with the Ventura County Sheriff's department in an effort to find the person behind the harassing and jamming. By now, NOAA weather radio was being retransmitted on every Oaks two-way channel. FCC told the Oaks workers to get the perp talking and to keep him going for as long as possible. The workers did and then listened to him tell them that he had warned of this three weeks ago, that they needed to cancel their license for the security repeater frequency pair, and that they should request a new frequency because "we need this channel."

That evening the FCC tracked the source of the voice to a vehicle in a parking structure of the National Park Service, just across the street from The Oaks. Kevin Bondy, the person in the vehicle, holds a GMRS (General Mobile Radio Service) station license. He was told that as a FCC licensee he had to allow an inspection of his transmitting equipment or face a possible fine. Bondy did not permit the inspection.

From then on, there was no further interference to radio operations at The Oaks. Three days later, the FCC went back to Oat Mountain and found that the beam antenna was gone. The FCC's Notice of Apparent Liability to Bondy cites unlicensed radio operation and intentional interference on a willful and repeated basis. It imposes a $24,000 fine.

Sheriff's officers executed a search warrant at Bondy's home, finding over 200 pieces of two-way radio gear. There were also a few amateur radio items and some commercial broadcast equipment, including a one-kilowatt FM transmitter. That office is now attempting to determine if any of this equipment was stolen.

Are you using your RDF skills to help the Official Observers in a Local Interference Committee of the ARRL Amateur Auxiliary? Please write and tell me about the success of that cooperation in solving the interference problems in your area.

Notes

1. Almost all of the 2-meter sets worked fine, but to everyone's surprise, many 80-meter receivers were pummeled at the starting line by WGBH-FM, the 100-kilowatt station on 89.7 MHz atop a hill at the southwestern corner of the reservation. Fortunately, the QRM diminished as hunters got into the woods closer to the foxes.

2. Competitors don't get to choose which foxes to omit. They are told in advance which fox numbers are the ones they must seek.

3. Championship 2-meter ARDF transmitters usually send A2 modulation (AM with CW tones). The RF carrier was keyed with the CW at this event, but sometimes the carrier is continuous.

4. The story of ARDF Team USA at the 2008 World Championships is in "Homing In" Fall 2008 *CQ VHF*.

5. Lori is the daughter of Ruth Bromer, WB4QZG, of Raleigh, North Carolina. Ruth also competed and received two gold medals in the W50 category.

6. "Tips for Hosting ARDF Championship Events" at <www.homingin.com/host.html>

7. I would like to credit this person by name, as well as the FCC staffers who handled the case, but they wish to remain anonymous.

By Rich Arland,* K7SZ

BEGINNER'S GUIDE

All you need to know but were afraid to ask . . .

It's Summertime . . . Antenna Time!

Summer is here, and about time, I might add! Man, I don't know about you, but there is something about this time of the year that inspires me to do a number of things around the shack/antenna farm. Coming out of the winter doldrums and the torrential spring rains, performing some antenna maintenance or rearranging the shack seems somehow the "correct" things to do.

In the spring issue of *CQ VHF* we discussed the shack, the ops bench, and a generalized list of things to do to get ready to operate. I had some excellent shots of my new shack ops bench, both uncluttered (shortly after I built it—about 3 hours later) and overrun with "stuff" (about 3 1/2 hours after I built it!), which serves to emphasized the FSS (flat surface syndrome) that accompanies a new piece of shack equipment/gear/furniture. Unfortunately, I managed to either misplace or delete the images in the camera! I *hate* when that happens!! However, you'll be relieved to know that I have conquered FSS, at least temporarily.

The emphasis of this column, to date, is to set up a new shack with the idea of using (and/or reusing) items from the old shack, or, if you are just starting out, guide you through the minefield of spending money when not really necessary. Frugal is the password in this endeavor. With today's economy in a shambles, taking a tight-fisted approach to a new shack is not only a sound idea, but one that should secure easy approval from the rest of the family.

On a recent return trip to our old home in Pennsylvania, I spotted my old shack operating position—a computer desk from the local Ikea store. It wasn't being used, so it made the return trip back to Georgia with us. This desk is quite roomy, in the way only the folks at Ikea can visualize, design, and manufacture. The reacquisition of this ops bench meant that the bench I procured at Wal-Mart earlier could be used as a workbench, thereby allowing me to keep an uncluttered operating area while doing maintenance on a rig or building a new piece of gear for the shack.

Photo 1. This is the five-pack of colored vinyl tape available for under $2.00 at Wal-Mart. This stuff is great for labeling large coaxial cables using a color code of your choice. Writing the desired cabling info on the tape using an ultra-fine tipped black "Sharpie" permanent marker yields a fool-proof method of keeping track of your cables inside the shack.

Coaxial Cable

One idea that struck me early on in planning phase of this new shack was to be able to route the RF coaxial cable and ladder line via a patch panel mounted on an inside wall of the shack. This idea turned out to be very simple to implement. I brought each coaxial cable from the outside antennas in under the eaves of the roof via holes under the eaves. From there each cable was routed across the inside of the attic and down the inside wall of the shack between the wall joists. An 8" × 8" square hole was cut into the sheet rock on the inside wall of the shack and each cable was brought out for prepping (affixing coaxial connectors) prior to drilling and mounting the aluminum patch panel to the wall. The patch panel, a 9" × 9" × 1/8" piece of aluminum stock, was drilled for various coaxial feed-through connectors to include BNC and SO-239 bulkhead connectors. Additionally, I added a set of feed-throughs for 300- and 450-ohm ladder line. The patch panel is attached to the wall via some sheet-rock mounts and makes for a very neat, professional antenna installation.

Each antenna is separately routed either directly to or via an Alpha Delta coaxial switch to the radios. This adds a lot of flexibility to the shack while keeping the rat's nest of wires/cables to a minimum. With the addition of wire labels (both on the input and output side of the patch panel) you can accurately grab the proper RF feed line if the need arises.

Speaking of cable/wire labels, RadioShack sells (or used to) several different types of labels. Of course they are drastically overpriced for what they are, so how about we make our own? Labeling your feed lines and AC/DC power cords not only makes sense, it doesn't need to be expensive.

For RG-6, RG-8X, RG-58, or RG-59, the plastic tabs from loaves of bread makes dandy labels. One side normally has some kind of date/time code stamp while the opposite side is blank, allowing you to write the info regarding the cable. This plastic tab is then placed around the cable near the coaxial fitting and *viola*, each cable labeled!

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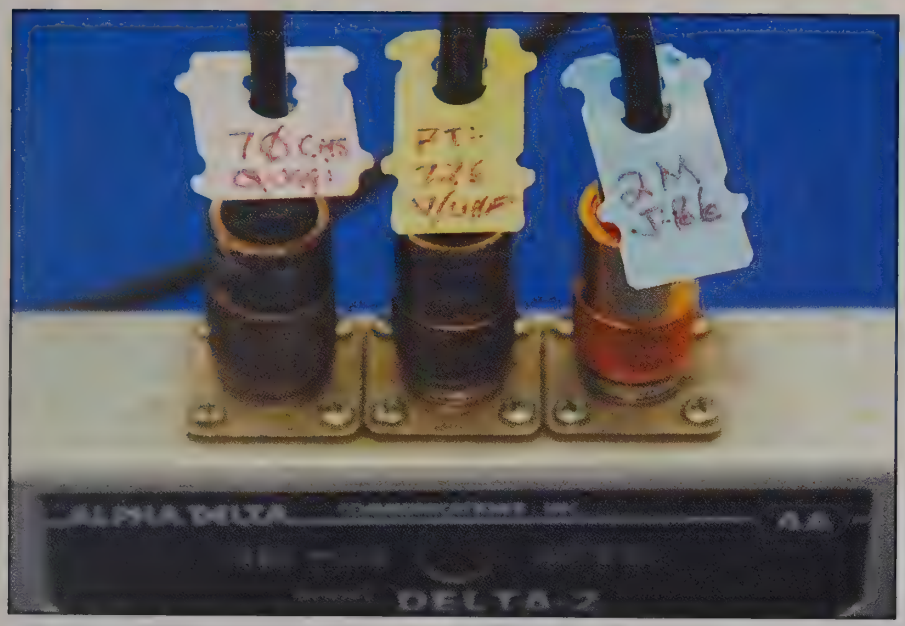

Photo 2. This photo shows how the plastic ties from bread/bagel bags can be used to tag smaller coaxial cable such as RG-8X, RG-58, and RG-59.

For larger cable such as RG-8, RG-11, RG-213, 9913F, or LMR-400/600, we need to do something different. Sure, you can hit the local RadioShack and pick up a selection of their pricey labels, or you can make a run to Wal-Mart and in their automotive center grab a selection of four rolls of colored electrical tape for less than $2.00! The selection of colors normally includes blue, red, yellow. and white, giving you four distinct color-coding schemes: blue for VHF, red for power cabling, yellow for HF, and white for whatever is left over. You can write on this type of tape using Sharpie® permanent markers (I prefer the ultra-fine-point type) so you know at a glance what cable you are looking at.

A spin-off of using the multi-colored electrical tape is you now have a method of labeling the various parts of your vertical and/or Yagi antenna elements. Match the colors to the proper ends of the aluminum tubing and you know instantly where each piece of tubing goes together to make your antenna. This is great for those types of antennas you might use for Field Day, portable/mobile operations, or VHF/UHF hilltopping when you need to quickly assemble the antenna without the instruction manual.

RF Feed Lines and More

Let's back up a bit and talk about coaxial cable and its role as an RF feed line. Coax has been around for over 60 years or so, being developed for the military during WW II. This type of RF feed line is considered to be "unbalanced," since normally one side (the shield) is connected to ground, as opposed to open-

Photo 3. A plastic tag on the coaxial cable for my QRP wattmeter. This is a very inexpensive way to assure that you can easily identify all the cables in your shack at a glance.

Finding *WorldRadio Online*

To access the current issue of ***WorldRadio Online*** as well as past online issues, helpful downloading tips and other information, you'll need to go to the *WorldRadio Online Welcome Page* on the *CQ* website.

Here's how to do it:

(1) Go to the *CQ* magazine homepage at <www.cq-amateur-radio.com>.

(2) Find the *WorldRadio Online* logo to the left of the *CQ* magazine covers. Click on it. This will take you to the *WRO* Welcome Page, where you will have several options. There are links to a variety of informational pages. We recommend that you read the "Viewing and Downloading Tips" before doing anything else. The Back Issues link will take you to previous issues (beginning 2/09) to download and view. **Enjoy!**

Photo 4. Antenna for SATCOM shows your author slaving away shortly before Field Day to put the finishing touches on an 8-element Quagi antenna for the 435-MHz downlink on AO-51. The original article was published in QST *about 20 years ago and it can be found today on the "Members Only" portion of the ARRL website. Follow the instructions and you will have an excellent high-gain, very inexpensive UHF antenna that will work on the low end of 70 cm as well as the satellite sub-band. The antenna in the original article was designed as a 15-element UHF Quagi, but I just shortened it by about half and got good results according to my MFJ Model 269 antenna analyzer. Rest assured that at least one of these 15-element antennas will be on the roof shortly. The 8-element one I built for Field Day 2009 will be my portable UHF antenna.*

wire or ladder (window) line (300, 450, and 600 ohm), which is considered to be "balanced" since both sides are normally above DC and/or RF ground. Coax is much easier to use and to route. Additionally, the outer shield of the coax helps reduce RF radiation from the feed line. There is a trade-off, of course, as coax is lossy, and the losses increase as the frequency of operation is increased.

Coaxial connectors come in a variety of shapes and sizes with the most common being BNC and UHF connectors (PL-259 and SO-239). N-connectors are used in UHF applications, but there is nothing sacred about this. I know hams who use N-connectors for all their RF feed lines, even those in the HF portion of the ham bands.

I know for a fact that there are a *lot* of folks out there in ham radio land who *do not* know how to properly install UHF and N-connectors. This can also be true of the alleged "professional" communications technicians: I recently received about 500 feet of RG-8 and RG-213 cables of various lengths taken from a local TV station during a remodeling of their studios and master control. Over half of them had either faulty or crudely installed PL-259s or N-connectors! This was from a commercial TV station that should be employing competent broadcast engineers! How did I find out about these errant connectors? Visual inspection of each connector caught most of the problem coaxial cables. However, I had the foresight to terminate each cable in a non-reactive 50-ohm "dummy load." Then, using a MFJ model 269 antenna analyzer, I swept each cable from 1500 kHz to 500 MHz. This caught an additional three cables that had what appeared to be properly installed connectors! The moral of this story is don't trust everything you see. Check, then double, check to be thorough.

As for the proper method to install BNC, PL-259 and N-type RF connectors on various sizes of coaxial cable, consult any edition of the *ARRL Handbook* or the *ARRL Antenna Book*. Both have excellent illustrated step-by-step instructions. Also, the *Radio Handbook* by Bill Orr, W6SAI (SK) has a slightly different method that I have used for over 30 years, and never, ever have I had a PL-259 connector fail! Just follow the instructions and you won't have any problems.

Now some of you will be asking yourselves, "Why would Arland use old, discarded coaxial cable in place of buying new, certified quality coax?" Glad you asked! Although these assorted lengths of large-diameter coaxial cable had been used for many years in the TV stations, they were never exposed to the ultraviolet rays of our sun, which will definitely degrade the coax over a period of time. These cables were all used indoors, between studios, master control, and video editing booths, so the normal degradation associated with outdoor coaxial runs does not apply. However, being ultra-conservative in my approach, I swept each piece of coaxial cable (again using the MFJ 269 antenna analyzer) to ensure that each cable would perform from HF right up to and including 70 cm.

Using these varied runs of surplus coax saved me a bundle, since I have four VHF/UHF omni antennas, an HF vertical, and a 3-element Yagi tri-band beam at K7SZ. Future expansion plans call for adding several OSCAR antennas along with a 2- and 6-meter and 70-cm terrestrial weak-signal antennas. These VHF/UHF antennas will get the 9913F or LRM-400 treatment, so the money I saved using the discarded coax from the TV station allows me to go first class on the high-band weak-signal arrays. After all, I am not a big fan of using the checkbook or a piece of plastic to buy my way to a new shack!

Antennas for my new shack consist of a Cushcraft R-5 vertical for HF, a 40-meter dipole fed with 300-ohm ladder line, and three KU4AB VHF/UHF "halo-style" antennas for 2 meters, 6 meters, and 70 cm (www.ku4ab.com). They nest quite nicely in about 4–5 feet of vertical mast mounted on the side of the rear porch. A Blue Star dual-band J-pole sits at the top of the stack (www.bluestarantennas.com). We'll talk more about these antennas next time, but suffice it to say, these antennas are a good value for the money.

On a final note, this column is being written just prior to Field Day. I hope I worked some of you either on HF or 6 meters, if the band opened up. I was providing the satellite station for the W4RG Field Day team. CU on the birds!

73, Rich, K7SZ

By Mark Thompson, WB9QZB

DIGITAL RADIO

Digital Technology on VHF, UHF, and Microwaves

Digital Connectivity: It's About the Network

Until the early 1980s operating the digital modes meant making a contact using RTTY on HF or VHF. In the early 1990s other data modes, such as AMTOR and PACTOR, using multi-mode controllers, were implemented by companies such as AEA, Kantronics, and MFJ. In the late 1990s new digital data modes—PSK, for instance—began to be implemented using software and sound-card technology. What all of these data modes have in common is that they're simplex half-duplex based and require no other network technology in order to use them.

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Packet radio was introduced in the early 1980s; this was the first time a digital network was implemented in ham radio. Every packet TNC (Terminal Node Controller) was a digipeater that could repeat a digital packet of information. In the early days of packet it became common to digipeat through several TNCs. During band openings it was often a challenge to see how far away you could digipeat and either connect to a remote TNC or BBS (Bulletin Board System). As packet radio became more popular, packet frequencies became very congested, with packets often colliding with one another. Digipeaters often were placed at high locations with the expectation of extending the range of digipeating. Unfortunately, these high-location digipeaters caused collisions called the *hidden transmitter effect.* The hidden transmitter effect occurs when not everyone on a frequency can hear one another, resulting in TNCs transmitting at the same time with packets colliding with each other causing a reduction of overall throughput. Consequently, high-location half-duplex digipeaters often increased

collisions and reduced overall throughput on a frequency. In some areas, full-duplex FM repeaters were put in place to eliminate the hidden transmitter effect, since all packet TNCs could hear all others on a repeater, resulting in the elimination of packet collisions.

Initially, packet radio was primarily a keyboard-to-keyboard activity. Bulletin Board Systems similar to dial-up BBSes soon were developed to allow users to send messages to one another. The ability to send messages from your local BBS to remote BBSes was added, and a message addressing scheme developed to support sending messages worldwide.

Since packet radio grew and evolved before the advent of the internet, a large terrestrial backbone network and HF backbone network was developed in response to the need to route messages between BBSes. Using packet radio on HF was not very efficient, but it did work. Packet radio network backbones were developed to allow a more efficient connection to a remote network node and to allow BBSes to route messages to one another more quickly and over longer distances. Many of the terrestrial backbone networks operated at a higher speed, 9600 baud, than regular packet radio, which operated at 1200 baud.

Many packet radio groups developed packet radio band plans designating both LAN (Local Area Network) and network backbone frequencies. To alleviate user congestion LAN frequencies were created for specific geographical areas. LAN frequencies reduced the number of users on a particular LAN frequency. LANs also tended to reduce the hidden transmitter effect and allowed digipeaters to be kept at a lower height.

Packet backbone networks were built by both individuals and packet radio groups. By the mid-1990s a very robust network was in place. However, when the internet arrived in the late 1990s hams started to use the internet for e-mail instead of packet radio, resulting in diminished use of packet radio. By the early 2000s network operators started to abandon their support of the networks due to reduced of use of the BBSes and the networks. Consequently, the packet network declined dramatically. Many BBSes were shut down and many packet users quit using packet radio entirely. Packet radio nearly fell into complete disuse until APRS (Automatic Packet Reporting System) was developed, resulting in a completely new use of packet radio on a new nationwide 2-meter frequency of 144.39 MHz.

The Winlink digital messaging system, developed over the last few years, has end-user access and message-routing capability. Winlink can use the internet for user access and message routing. Winlink can also be accessed independent of the internet using packet radio for users with messages routed using RF, typically over HF. Winlink HF routing typically uses the proprietary Pactor III mode. However, a new sound-card-based mode, Winmor, was introduced at the Digital Communication Conference last year with the intent of reducing the cost of implementing Winlink message routing.

D-STAR digital voice repeaters can operate stand-alone and automatically route voice transmissions to other D-STAR repeaters at the same site. However, a significant capability of D-STAR is the ability to use the internet to route digital voice transmissions to remote repeaters. Since all D-STAR transmissions are identified by callsigns, transmissions can be routed using an internet gateway. D-STAR repeater sites in a common geographical area could also be linked via RF using IP-based networking technologies.

The packet radio experience demonstrated that a reliable network is required to implement a robust digital messaging system. While a ham network can now use the internet, it is desirable that a separate network be developed independent of the internet so communications can continue when commercial networks fail during a disaster.

I encourage everyone who has an interest in digital voice and data communications to attend the Digital Communication Conference. The DCC will again be in Chicago this year the last weekend of September (the 25–27). It is a great way for both experienced and new operators of the digital modes to learn more about the technologies. There are both technical and introductory presentations. If you have experience using digital data or voice technology, or have an innovative new digital technology, please consider submitting a paper to be included in the *Proceedings* and/or presenting a topic at the DCC. You can learn more about the 2009 DCC at: <http://www.tapr.org/dcc.html>.

I look forward to seeing many of you at the DCC this year.

73, Mark, WB9QZB

By Mitch Gill, NA7US

EMERGENCY COMMUNICATIONS

The Role of VHF in EmComm

Tips, Tricks, Camping, and Field Day

Good day, and I hope you all are having a great summer. My wife Jan and I do a lot of camping; well, only if you can call living in a 27-foot travel trailer camping. We have gotten too old for lying down on a hard, rocky floor or blow-up mattresses. There is a major advantage of owning a trailer, too, as I am ready for any emergency. I have solar cells, inverters, water, battery power, a place to sleep, food, and my radios. Now I am not suggesting everyone go out and buy a travel trailer, as that would lower my chances of camping wherever I choose, but I do advocate having a fly-away kit set up and ready to go.

Choose Your Radio Carefully

What kind of radio is best? In almost every type of local emergency, in my humble opinion (did I say "humble"?) the best radio is one that operates on 2 meters. There are a lot of reasons I believe this, but I will name only a few. First and foremost is that 146.52 MHz is monitored by more people than any other frequency and is designed to be an emergency frequency. Many people have a 2-meter radio around somewhere. Small antennas, repeaters for greater distances (if they are still up and working), and all operate on a battery or 12 VDC. Everyone in my family has a 2-meter radio in their vehicles. My son Tyler, KD7MJO, is licensed, and my wife is working on her ticket now. We have several radios in the trailer, as I am both prepared for an emergency and when I just want to have fun on HF, VHF, or UHF.

My wife had no problems with my setting up a station in the trailer. OK, she had one rule—no holes in the new trailer, which became my problem. I scouted for ways to bring in the antenna cable. I looked at all the vents, and the only one that would have worked went down to the refrigerator, which was not a good place to put a radio. I also forgot the first rule also applied

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Photo A. The radio towers at Fort Flagler. They are about 10 feet below the ground, as they are attached to the side of the underground bunker. (Photos by the author)

Photo B. The view from the VHF tent overlooking Admiralty Inlet on Puget Sound.

to mounting any radio. I had to put my foot down someplace and this was the time and the place. What was I, a man or a mouse? I decided that this was much too important, and she would just have to let me bend or even break the rule! I went marching into the house and into the kitchen and told her what I was going to do and that there was nothing she could do about it. She merely smiled, opened the refrigerator door, and handed me a piece of cheese. Drat! I will have to find another way.

Returning to the trailer with head lowered and my ego reduced by several notches, I suddenly remembered how I got an antenna into my room in Iraq (see NA7US's column in Spring 2009 *CQ VHF*). I cut the top and bottom off one 1.5-liter bottle and the tops off two more and then taped them together and placed them in the window so that it closed down onto the bottles. I drilled the holes and brought in the cable. No holes in the house. On the serious side, you can do this in the event that you lose electricity and the drill does not work. By poking a hole on each side and taping up the hole, you will lose very little heat in the winter.

I ended up buying the MFJ 4603 Universal Window Feedthrough Panel for my house, as I did not want to drill holes through the cedar siding and the XYL would not like the bottles in the window. It's a great product for us lazy people who do not want to build anything, but it would not work on the trailer, as the windows are a different size and shape. I tried the bottle idea, but my window in the trailer is curved, and I could not get it to work no matter how hard I tried to squeeze that plastic.

I then remembered that my son had some extra Plexiglas lying around in the garage. I created a window and set it in place and it worked! I put a barrel connector in the middle and ran my screwdriver power cable through another hole. The great thing is that I can easily remove it when we are traveling. It's not pretty, but it works.

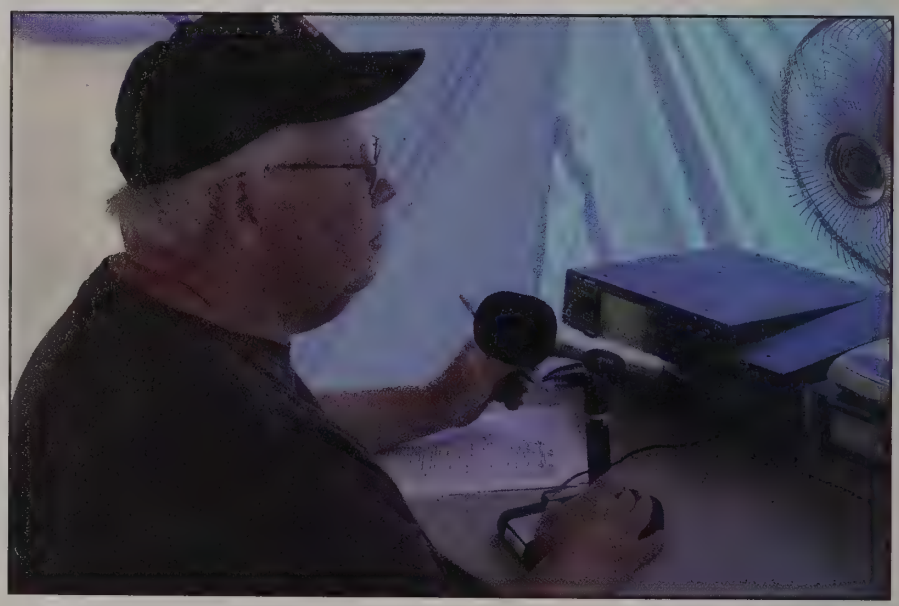

Photo C. John, WA7HQG, the "Upper Band Prince" during Field Day. He can wrack up the points!

I can hear you now: "Hey, Mitch that's great for you, but I don't have a trailer!" That may be true, but you can get a deep-cell battery, a solar panel, and pitch a tent. No tent, you say? In that case you may get wet and the radio may fry! That would not be good.

There are, of course, many more items that can be placed in a fly-away kit, and there are many different ideas of what those items are. Do your research, because only you can choose what you believe needs to be in there.

Field Day: Testing Our Emergency Comm

I love Field Day for so many reasons. The club I belong to (Mike and Key Amateur Radio Club) has been going to Fort Flagler for over 35 years. The view of the ocean, history, campfires at night and walks on the beach with my wife make for a wonderful time, but it is the rush of working a pile-up that keeps me returning every year, as well as the many friends I have made over the years.

Fort Flagler was one of the three forts built in the late 1800s to protect the entrance to Puget Sound. If ships were to get through, they could have destroyed Seattle, Tacoma, Everett, and the Bremerton Naval Shipyard. The radio towers you see in photo A are actually about 10 feet below the ground, as they are attached to the side of the underground bunker.

It may seem to some people that Field Day is more of a contest than a test of emergency communications. There may be some truth to that statement, but personally I believe that any time we go "off the grid" and can effectively communicate, we are demonstrating what we, as ham radio operators, can do. Also, when the generator fails or the rotor dies, we know how to improvise with batteries and dipoles.

Imagine the view from the VHF tent (photo B). It was overlooking Admiralty Inlet on Puget Sound, and there have been times when a pod of orcas or humpback whales can be seen breeching the water in the early evening with the Cascade Mountains in the foreground.

John, WA7HQG, is the "Upper Band Prince" during Field Day (photo C). He can really rack up the points! The four-element 6-meter beam was developed and built by him a few years back. When we were breaking down the antenna I noticed just how well the beam had been built. Send an e-mail to his attention via my e-mail address and ask.

Take to the Field

The real test of emergency communications during Field Day (before I get a lot of e-mails, just remember that this is my opinion) is those who take their batteries, solar panels, and VHF equipment out in the field or up in the mountains. When a real catastrophe strikes, it will be those operators who will first respond and assist their neighbors while I am still trying to start my generator. OK, you now know that I am not mechanically or electrically inclined, but that's what I have sons for. All three of them are mechanics and one is an electrician as well. I had a plan!

What really matters is that we prepare ourselves for a time when we may be called upon to assist. Many of you have been through the storm already and bring tons of experience to the table. Teach and then practice what you have taught. Let your neighbors know that you can be of use in the event that there is no other communication. Prepare for the worst and hope for the best.

Until next time, just remember that VHF rules during local emergencies. Thank you for your service.

73, Mitch, NA7US

By Bob Witte,* KØNR

FM

FM/Repeaters—Inside Amateur Radio's "Utility" Mode

A List of FM VHF Operating Activities

How many times do you hear someone comment, "2 meters FM is just too limiting. All you can do is chat on the local repeater"? It is easy to draw that conclusion, and there is certainly nothing wrong with chatting on repeaters—a lot of good ham activity happens that way. FM is the *Utility Mode*, which means it is the mode that gets the job done *and* it is useful for many different ham radio activities. The use of FM VHF is only limited by your imagination.

Let's see if we can expand our thinking a bit and discover some of the "other" radio activities on FM VHF/UHF. In fact, I've made a first cut at a list of FM VHF operating activities.

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Here are the rules for the creation of this list:

- To be on the list, the activity must be possible using a typical dualband 2m/70cm FM transceiver (handheld, mobile, or base) and associated accessories (antenna, power supply, transmission lines, packet TNC, computer sound card, etc.)
- Commonly available ham radio infrastructure can also be used, such as repeaters, VoIP links, OSCAR satellites, Winlink, etc.
- The author of this column will determine whether an activity is unique or a duplicate of another item. This will be arbitrary and capricious.

I spent some time reviewing the pile of ham radio magazines I have around the house, pulling out anything related to FM VHF. In the process, the following list was created:

Photo 3. Steve, KDØBIM, operating 2 meters FM from a vehicle located on Pikes Peak.

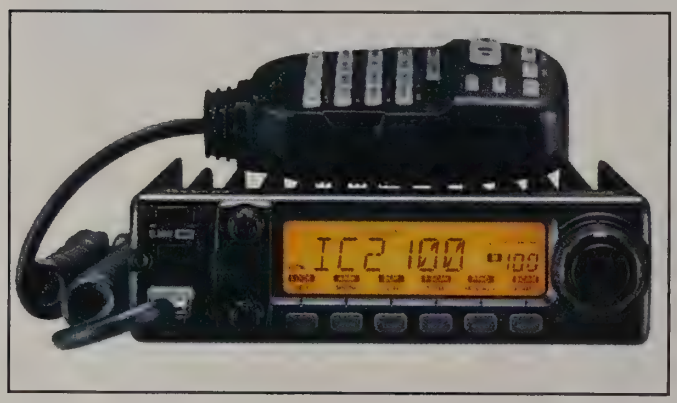

Photo 1. A typical 2-meter FM transceiver is the utility mode rig that can be applied to many different types of operating.

Photo 2. Joyce, KØJJW, operates VHF/UHF FM from the summit of Humboldt Peak. →

Photo 4. This sedan has a good collection of VHF/UHF vertical antennas installed. A good mobile installation makes for a fun road trip, but you can probably do just fine with fewer antennas than this.

1. Chat with your buddies on VHF simplex. (OK, that was an easy one.)
2. Make a contact via the local FM repeater.
3. Check into your local club FM VHF net.
4. Operate from a mountain or hilltop and take advantage of Height Above Average Terrain (HAAT).
5. Take a road trip with the goal of making contacts on VHF FM.
6. Report severe weather during a Skywarn severe weather net.

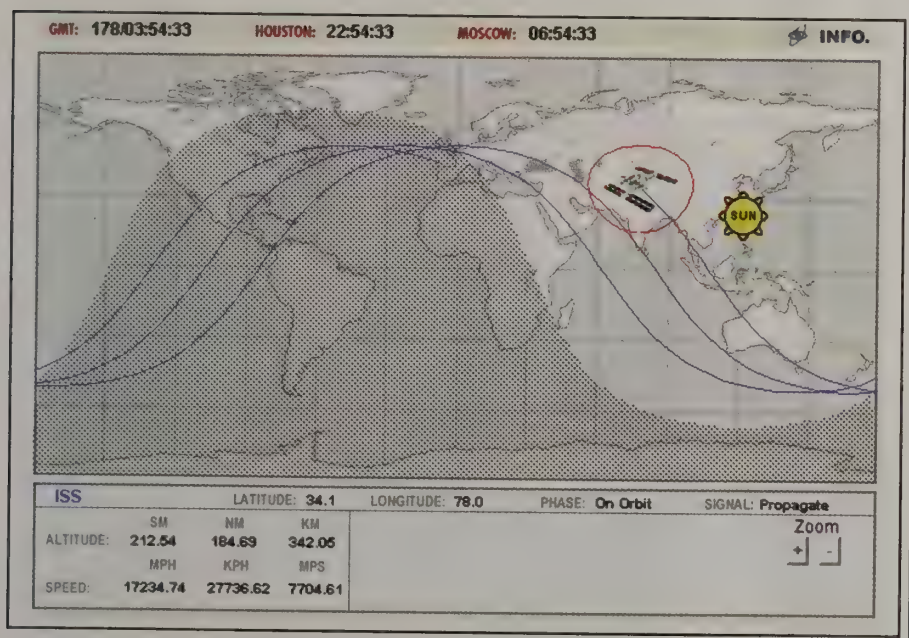

Photo 5. Online tracking of the International Space Station is available on <spaceflight.nasa.gov>.

Photo 6. The vertical 2m/70cm antenna is attached to a mast using a "drive on" mount.

Photo 7. A QSL card from a contact with the International Space Station.

7. Provide communications for a public service event.
8. Participate in ARES or RACES activity during an emergency.
9. Activate a rare grid or location, especially during a VHF contest.
10. Transmit your fixed or mobile location using APRS (Automatic Packet Reporting System).
11. Send a text or e-mail message using Winlink via a local VHF node.
12. Experiment with different homebrew antenna designs.
13. Obtain directions to a hamfest via the talk-in frequency.
14. Work the ARRL Field Day on the VHF bands (but don't use 146.52 MHz).
15. Make a phone call using a repeater autopatch.
16. Participate in a transmitter hunt using a directional antenna.
17. Complete a QSO using one of the FM amateur satellites (for example, SO-50, AO-51).
18. Contact the International Space Station on 145.80 MHz.
19. Celebrate the birthday of Edwin Armstrong, the inventor of FM, by making a commemorative transmission on December 18th. (He was born in 1890.)

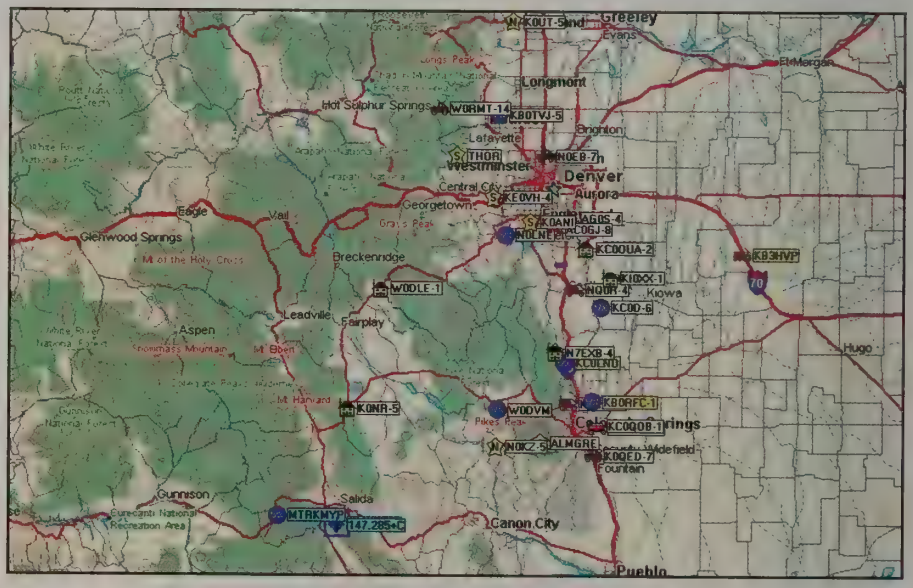

Photo 8. The mapping of station locations using APRS.

Photo 9. The N7EXB portable station in use at Field Day.

Photo 10. The FM OSCAR satellites can be worked using an HT and a handheld Yagi antenna.

Photo 11. AMSAT offers the Satellite Communicator's Club Award for just one satellite contact.

20. Listen to the NOAA weather radio stations on 162 MHz.
21. Talk to radio amateurs around the world via IRLP or EchoLink.
22. Set up an EchoLink node using your transceiver.
23. Use crossband repeat to extend the range of your hand-held radio.
24. Control a remote device using a DTMF sequence.
25. Practice Morse Code using AFSK (keyed audio into the mic input),
26. Work several hundred miles on simplex via tropospheric ducting.
27. Track a radio-equipped balloon or model rocket through its flight pattern.
28. Track down ELTs (Emergency Locator Transmitters) on 121.5 MHz.
29. Track down power-line noise using the AM receive mode on VHF.
30. Set up a packet radio digipeater at your location.

By now, I hope you have found at least one or two things on the list that you might want to add to your ham radio activities, or maybe you found something that I missed. If so, drop me an e-mail and I'll add it to the list.

Thanks for taking the time to read another one of my columns on the *Utility Mode*. I always enjoy hearing from readers, so stop by my blog at <http://www.k0nr.com/blog> or drop me an e-mail.

73, Bob, KØNR

By Bill Brown,* WB8ELK

UP IN THE AIR

New Heights for Amateur Radio

Mobile Streaming Video

Now that high-speed wireless internet service is available in most areas of the country, it's now possible to televise live streaming video while mobile or portable with lightweight equipment. When doing a balloon launch, or any kind of activity—such as Field Day, special events, and hamfests—this is a great way to share your event with viewers from around the world.

I investigated some of the most popular "free to the general public" streaming video websites (Camstreams.com and Ustream.tv, for example), and although you can certainly use these sites for your streaming video and there are many hams using these sites, you may have to put up with some restrictions, such as limited number of viewers at one time as well as some advertising.

For an event that might generate a large viewing audience, I found that the best choice for me was to join the BATC (British Amateur Television Club) with yearly dues of 4 pounds (about $5.50 US). On its website (www.batc.tv) you get a dedicated personal "Members Streams" area where your streaming video link will be always be shown on the list whether you are using it or not and will immediately activate once you start your video. A nice plus is that you get to download the Cyber version of the club's *CQ-TV* magazine as part of the deal. Note that you do not need to be a paid member in order to view the video streams and events.

I have successfully used this to televise a number of balloon launches with great results. At one point we had over 100 viewers in several countries. The BATC indicates that their capacity should allow several hundred viewers at one time. One nice feature is its chat room area next to the viewing screen. Please note that to get your callsign or name to show up (if you haven't logged onto the BATC website as a member) is to use the command: /nick CALLSIGN (e.g., /nick WB8ELK).

At any given time as you scan through the Members Streams, ATV repeaters, or the special Live Events area, you'll see a number of hams around the world sending streaming video.

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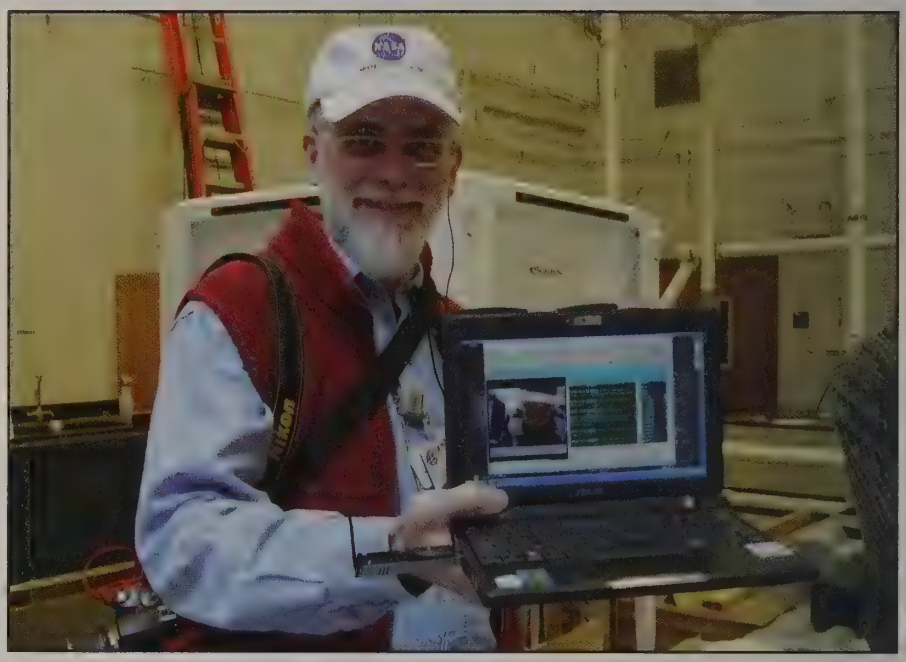

Photo 1. Alan Sieg, WB5RMG, demonstrates the portable streaming video system. (Photos by the author)

Uplinking Your Video

The hardware needed to uplink a portable or mobile video stream is not at all hard to do anymore. I use an ASUS EeePC netbook computer that weighs just a little over two pounds (see photo 1). Another good choice would be the ACER Aspire One series. If you are near a WiFi HotSpot, you can link in directly that way via the netbook's internal WiFi module. However, for more remote areas, I use the Verizon Wireless USB727 modem. It requires an additional monthly service fee, but the modem cost is fairly reasonable and sometimes is free depending on the length of term of your contract. You get 5 gigabytes of uplink bandwidth each month (I recommend not exceeding this

Photo 2. The Adobe Flash Media Live Encoder software.

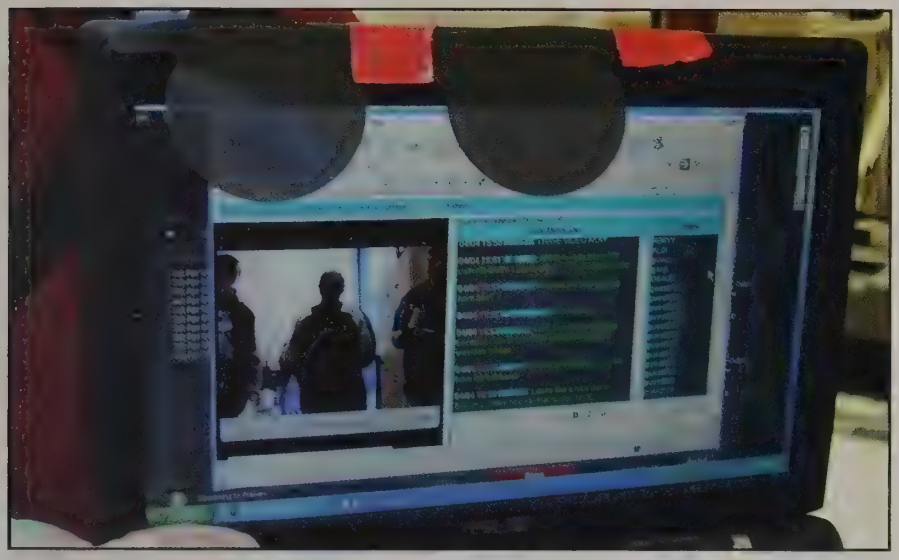

Photo 3. Laptop sunglasses for outdoor use.

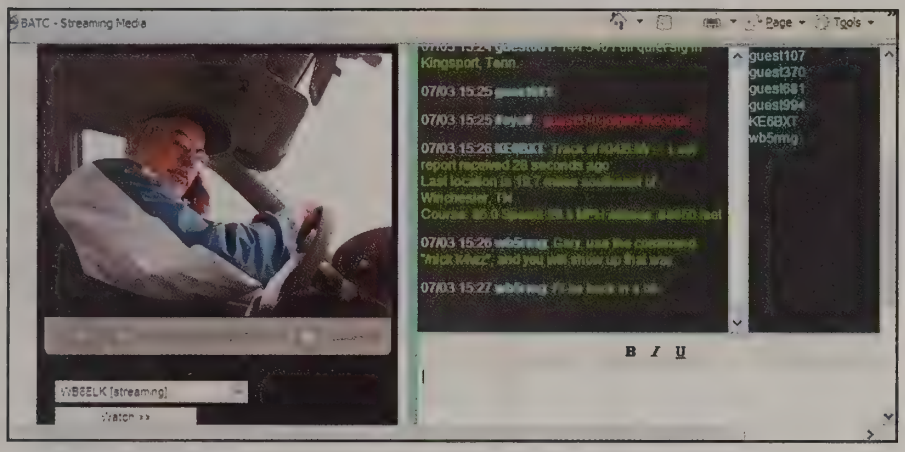

Photo 4. WB8ELK's mobile streaming video as seen on the BATC.TV website.

limit, since the extra charges rack up pretty fast). However, at the streaming video setting recommended by the BATC, it works out to about 80 megabytes an hour of use, which in the case of occasional 4-hour weekend events is plenty for my use. If you are planning to do continuous webcam monitoring, just be careful to monitor your monthly limit or use a WiFi link instead.

All you initially have to do to set up your computer for streaming video via the BATC website is download Adobe's free Flash Media Live Encoder 3 software. This software shows your live camera video on the left and the outgoing streaming video on the right-hand viewport (see photo 2).

Various uplink-speed options can be configured for both the video and the audio. Depending on the quality of your WiFi or cellular wireless connection, you might have to reduce the speed setting for optimal results for both the video and audio uplink. Once you have joined the BATC and requested your own streaming video area, you'll get an e-mail from BATC with its recommended settings for the Flash Media Encoder software. You'll also have to enter the FMS server path provided by BATC as well as the stream name (usually your callsign).

To start your stream, all you do is connect to the internet via your wireless cellular modem or via a WiFi Hotspot. Then start the Flash Media Live Encoder software and click the Connect button. Once connected to the BATC server, just simply click the green Start button on the bottom to start your video stream.

With the stock battery pack in my ASUS EeePC, I get about 2 hours runtime while walking around filming an event. Some of the newer ASUS and ACER units come with larger battery packs with much longer lifetime, but at the expense of making the laptop a bit heavier. Of course, in a mobile application you can use a DC/AC inverter to operate using the existing external AC power supply.

You can use a larger laptop computer as long as you have a video camera attached to it, but for true portability, you'll appreciate these lightweight netbook computers that seem custom-built just for this purpose. The ASUS netbook is so lightweight that I just carry it around like a camcorder. I did find that the built-in webcam is optimized for indoor use and is quite overexposed outdoors. The solution was to use a pair of sunglasses taped to the lid of the netbook, which worked beautifully (see photo 3).

Note that the BATC has a special "Live Events" section on their streaming video website as well. If you expect (or would like) a large audience for your event, you can e-mail them and they may be able to add you to their list of upcoming events with a special link in this section.

The quality of the video and the clarity of the audio is superb (see photo 4). If you're looking for a way to include the world during your event, this is the way to do it. 73, Bill, WB8ELK

By Miguel Enriquez, KD7RPP

ATV in the Classroom: Helping Make History

Jhovana Peralta, KF7DDD, is a junior at Pueblo Magnet High School, where I teach mathematics. Jhovana is also a teacher, of sorts. She is part of an experiment to determine if amateur radio has a place in the public school curriculum.

Beginning with the fall semester of the 2009–2010 school year, the Tucson Unified School District (TUSD) will add ham radio as part of the curriculum in an attempt to evaluate its use toward providing high school students with better math and science literacy and competencies. Students successfully completing the class can use it as an elective to meet high school graduation requirements.

The class, "Amateur Radio, Space and Wireless Technologies," will be funded in part by Joint Technologies Education District (JTED) resources. The ARRL is the major impetus behind this exciting endeavor. Through their generous contributions of equipment and materials and their Teachers Institute, which provides direct support for teachers in the classroom, the ARRL is making this opportunity possible. The combination of student, school district, and ARRL support will, hopefully, pave the way for this class to become part of the established curriculum for the more than 56,000 students attending the 100-plus schools in the TUSD.

Additionally, ATV will be a major part of the implementation strategy for this class. Jhovana will take the lead role of "instructor" both for the students in the classroom and for students elsewhere tuning in on the internet to watch the math and basic electronic lessons that will be presented. These classes will be presented in 3–5 minute vignettes teaching basic concepts. To avoid "broadcasting" issues, licensed hams are being recruited to provide for two-way ATV QSOs.

Stringent Arizona Department of Education requirements will have to be met. Students must meet 80% of established Academic Standards to successfully pass the class. These standards are defined by industry standard criteria in video and audio production.

Jhovana is spearheading a group of Pueblo Amateur Radio Club students who will be responsible for production both "behind and in front of" the camera. Jhovana will assign duties and responsibilities to her fellow classmate as needed to successfully meet the classroom objectives. Jhovana will also supervise her fellow students as they go about producing the programs, which will ultimately constitute a complete course in basic algebra and basic electronics.

The Pueblo ARC students will also use ATV to demonstrate ham radio to students in other high schools throughout southern Arizona. Plans are under way to schedule trips to nearby communities for the purpose of introducing students in math and science classes to the exciting technologies that amateur radio employs. A marketing plan for "getting the word out" includes use of text messaging and Twitter technologies. Plans also include using MySpace as a venue for developing more student involvement.

Jhovana and the Pueblo ARC students know that our quest is an ambitious but serious undertaking, and they accept the responsibility for making it a successful adventure. However, behind every great dream there is the reality of everyday life and its demands, especially for a bunch of high school students.

As I listen to their plans for accomplishing objectives, I cringe many times as their naiveté has them building castles in the sky, and unless I see disastrous consequences, I let them find out the hard way. They have not made the same mistakes twice, save for connecting the terminal leads from the battery to a power supply before turning it on. Even so, I figure the amount of time and effort it takes to repair the power supply might just save

Jhovana Peralta, KF7DDD, at the microphone having her first QSO during Field Day 2009 with Ralph Gibbs, AE5IC, in Carrollton, Texas. Standing behind her is Yaritza Martinez, another Pueblo ARC student.

*c/o Pueblo Magnet High School Amateur Radio Club, 3500 S. 12th Ave., Tucson, AZ 85713
e-mail: <enriquezma@cox.net>

Jhovana Peralta, KF7DDD, and Yaritza holding TX/RX antennas for ATV QSO during Field Day 2009.

them from more dangerous and expensive mistakes later on.

Our Allies

There are times when unrelated forces seem to converge and present never-before possibilities. The Tucson Radio Society (TRS) is one of the radio clubs in Tucson. They are making plans to get back into ATV, since forest fires destroyed the ATV repeater many years ago. The University of Arizona Amateur Radio Club is also looking to get back into ATV. Also The University of Arizona has dedicated resources for recruitment of high school students into its math and engineering programs. All of these possibilities provide for similar long-term self-interest opportunities for our club.

Jhovana has attended several meetings at the University of Arizona for the purpose of building the social and working networks that will ultimately help make our experimental class using ham radio at a high school a reality.She has grown from a shy, awkward high school freshman into a confident, resilient teenager who accepts the challenges of creating and developing new possibilities for herself and others. Her favorite response when asked to venture to go into unfamiliar territory is "I don't know if I can do it, but I'll do my best."

ARRL Teachers Institute

I conducted the Arizona ARRL's Teacher's Institute (TI) June 15–18, 2009. The institute included 16 local teachers. Three of the teachers were from the University of Arizona. Because of their interest, leadership at UA is also showing an interest in future collaboration and possibly participation in the Arizona Space Grant Program. Additionally, future TI classes may be held in a laboratory on campus.

One of the TI students, Karen William, is a fourth grade teacher from one of the elementary feeder schools for Pueblo. While skeptical of the curriculum at TI at first, she came away in awe with the prospects of incorporating amateur radio into the elementary school curriculum.

An "ah hah" moment occurred for the students when they were experimenting with combining two signals inside a mixer. The result was a new signal on a different frequency. The "ah hah" moment came when the students realized that the mixing process was explained mathematically.

The next generation of the League's Technical Institute training is the Advanced Teacher's Institute, or simply TI-II. It will focus on space technology. Curriculum is under development that will focus on the use of orbiting satellites for amateur radio communication. Thanks go to the genius of Mark Spencer, WA8SME, the League's Education and Technology Program Coordinator, for the curriculum development for this next course.

Field Day

Field Day 2009 proved to be another ally for the Pueblo ARC. Pueblo ARC students were invited by the Tucson Radio Society to join them on Mt. Lemmon and participate in Field Day activities, an event my students had read about but never participated in.

Witnessing ham operators operating various types of rigs using a multitude of antennas was an eye-opening experience for my students, who are used to the limited radio equipment we have available in our school ham shack.

The Pueblo ARC students also had the opportunity to take their portable ATV system on the road. They were successful in transmitting the ATV signal to the repeater, but the system designed by others to provide video streaming to the internet failed. This was perceived by the students as another "Bob-the-Builder" opportunity for them to build their own system for distribution of the signal.

While our students were quite impressed with the Field Day operations, they also impressed the TRS members. Although we were only able to bring three students to the Mt. Lemmon site, other members of the class were present at other Field Day sites, also making an impact on the event.

Summary

We hear and say many times that the future belongs to our youth, but many times those words do not reflect our actions. At Pueblo Magnet High School, the poorest most challenged school in Tucson, Arizona, we are watching a whole bunch of kids defying the odds and rising to the occasion by venturing into areas they do not even know exist, and in doing so they are contributing something of value to mankind.

Our ham radio class is something really big—at least the kids think so. As Jhovana explains, "We don't really know most of the time exactly what we are doing or why, but it's fun!"

73, Miguel, KD7RPP

By Kent Britain,* WA5VJB

ANTENNAS

Connecting the Radio to the Sky

Frequency Selective Surface

Wow . . . 25 years ago you could get into serious trouble with security for even saying the phrase "frequency selective surface" (FSS) outside of a secure area.

The idea is simple—to make a sheet of metal become transparent at some radio wavelengths and reflective at other radio wavelengths. The idea has been used in optics for centuries, a sheet of glass that blocks some wavelengths but passes other wavelengths—blue, red, whatever color you want. I would like to thank Jerome Glaser, W6RSF, of Glaser Associates for photo A of the L-Band FSS.

Back then, 25 years ago, the development of frequency selective surfaces was a very important factor in the design of stealth aircraft. An antenna makes a great radar target. A 1/4-wave whip will reflect radar on all of its 1/4-wave multiples. However, if you put that antenna under a surface that only lets one frequency pass, then your antenna is no longer a microwave radar target. The surface of the aircraft looks like a smooth surface to the microwave radio waves.

Frequency selective surfaces also have ham and commercial uses. In figure 1 we have one of the simpler FSSes. It's just an array of crossed dipoles tuned for the frequency of interest. In this example we will tune the "+" for 12 GHz, the Ku satellite band.

In figure 2 we have an example of a dual-band dish using a FSS. The prime feed at the focus of the dish is tuned to the 4 GHz C-Band. The 12-GHz Ku-Band frequency selective surface is transparent at 4 GHz and the dish works as a prime focus dish at 4 GHz. However, at 12 GHz the signal sees the FSS as a Cassegrainian sub reflector. Thus, for Ku-Band the dish is really a Cassegrainian feed dish. Now both 4-GHz and 12-GHz systems can work without interference or blockage.

Let's take it a step further and add a 6-GHz FSS as shown in figure 3. Again the 4-GHz and the 12-GHz signals do not see this 6-GHz surface and the 6-GHz signals think they have the dish to themselves. This can often result in a more efficient dish design than using a multi-band dish feed and gives the antenna designer a broad range of design options.

Now let's take a piece of good old chicken wire, or as the feed stores like to call it, poultry netting. Chicken wire makes about a 3-GHz high-pass filter. Signals below 2 GHz reflect back from the wire; signals above 4 GHz pass through the holes. Therefore, you can think of chicken wire as a simple high-pass filter.

Next take a pattern that is the exact opposite of chicken wire—in short, a metal pattern that is pretty much the negative image of chicken wire, with copper where the chicken wire had openings, and openings where the chicken wire had

Photo A. L-Band frequency selective surface. (Tnx to W6RSF)

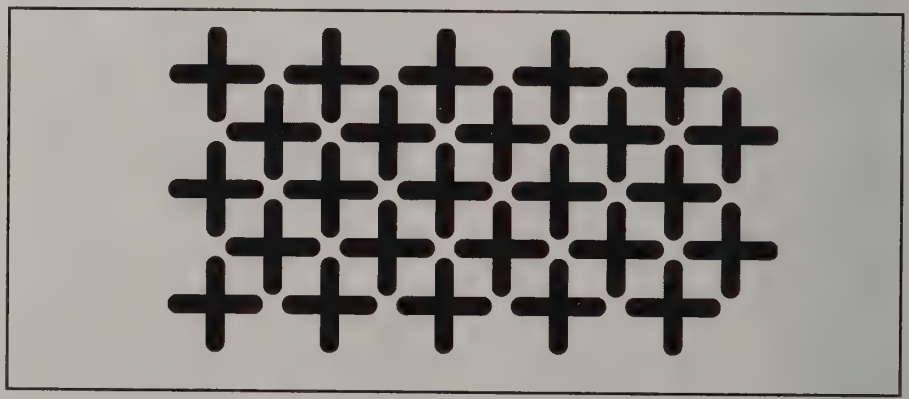

Figure 1. Pattern for a reflective frequency selective surface.

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e-mail: <wa5vjb@cq-vhf.com>

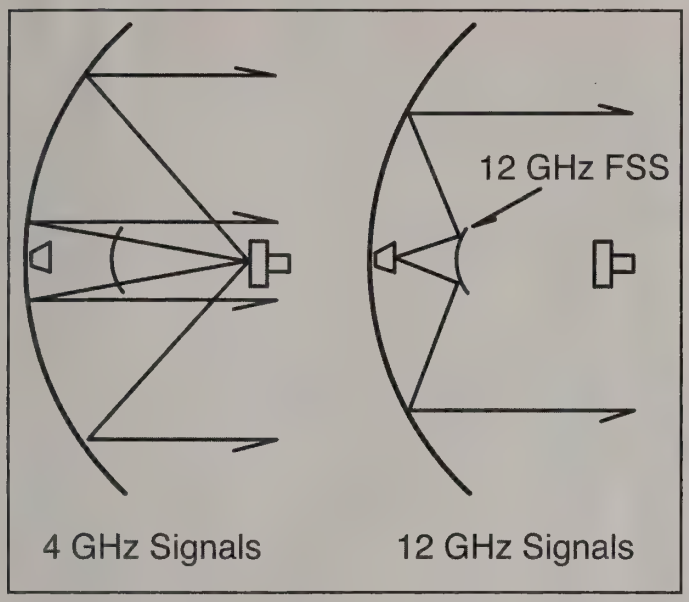

Figure 2. Using a 12-GHz FSS as a dish sub-reflector.

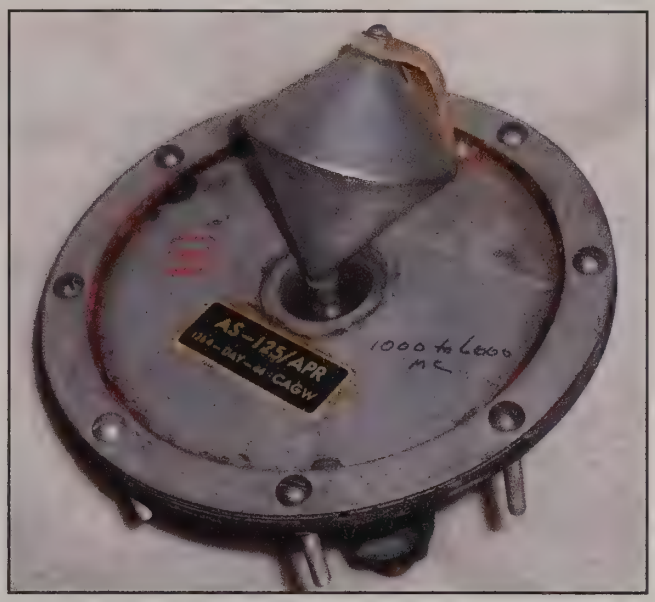

Photo B. AN-125 electronic warfare antenna.

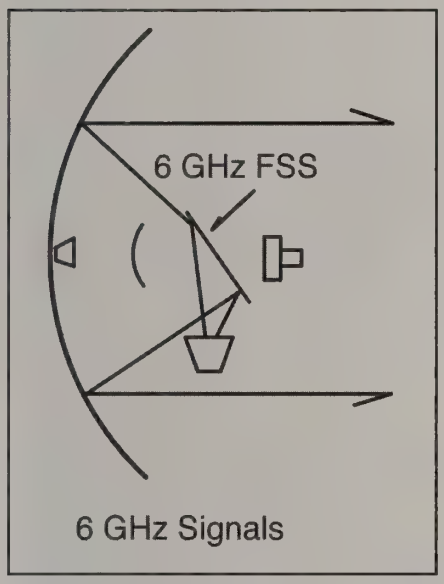

Figure 3. Adding a 6-GHz FSS for a third frequency.

wire. This array of close-spaced hexagons acts like a 3-GHz low-pass filter. Signals below 2 GHz pass right through. The hexagons are too small to stop the radio wave. Above 4 GHz this pattern starts to look like a continuous sheet of metal to the radio waves. Of course, far more sophisticated patterns and techniques are in use, but this gives you the basic idea.

There are FSS designs that are high-pass filters, low-pass filters, passband filters, and band notch filters, giving the antenna engineer or the aircraft electronic warfare engineer a lot of tools with which to work.

The technology of frequency selective surfaces has not really filtered down to any ham radio applications, but keep an eye out. Now you will be able to recognize a FSS when you see one.

Really Neat Antennas

I'm always a sucker for a strange antenna at a fleamarket—well, if the price is in my range. Here we have the receive antenna from an AN-125 jamming system (photo B). If you need to jam a radar or a communications link, you first have to find it. Therefore, this was the receive antenna with which you found the other guy, zeroed in on his frequency, and electronically took him out. That the antenna is marked 1000–6000 mc (megacycles) gives you the first clue as to its age.

As you make the center element in your 1/4-wave vertical wider and wider, it works over a wide range of frequencies. They have certainly made this vertical antenna about as fat as they can, thus giving it a very wide bandwidth.

Next Time

I have some material started on pitfalls in building helix antennas, but you never call tell what might come up to add to it. As always, we enjoy your input and suggestions for future topics. Please use the snail mail and/or e-mail address on the first page of this column. You can also visit <www.wa5vjb.com> for additional antenna construction projects.

73, Kent, WA5VJB

CQ's 6 Meter and Satellite WAZ Awards

(As of July 1, 2009)

By Floyd Gerald,* N5FG, CQ WAZ Award Manager

6 Meter Worked All Zones

No.	Callsign	Zones needed to have all 40 confirmed
1	N4CH	16,17,18,19,20,21,22,23,24,25,26,28,29,34,39
2	N4MM	17,18,19,21,22,23,24,26.28.29,34
3	JI1CQA	2,18,34,40
4	K5UR	2,16,17,18,19,21,22,23,24,26,27,28,29,34,39
5	EH7KW	1,2,6,18,19,23
6	K6EID	17,18,19,21,22,23,24,26,28,29,34,39
7	K0FF	16,17,18,19,20,21,22,23,24,26,27,28,29,34
8	JF1IRW	2,40
9	K2ZD	2,16,17,18,19,21,22,23,24,26, 28,29,34
10	W4VHF	16,17,18,19,21,22,23,24,25,26,28,29,34,39
11	GØLCS	1,6,7,12,18,19,22,23,28,31
12	JR2AUE	2,18,34,40
13	K2MUB	16,17,18,19,21,22.23,24,26,28,29,34
14	AE4RO	16,17,18,19,21,22.23,24,26,28,29,34,37
15	DL3DXX	18,19,23,31,32
16	W5OZI	2,16,17,18,19,20,21,22,23,24,26,28,34,39,40
17	WA6PEV	3,4,16,17,18,19,20,21,22,23,24,26,29,34,39
18	9A8A	1,2,3,6,7,10,12,18,19,23,31
19	9A3JI	1,2,3,4,6,7,10,12,18,19,23,26,29,31,32
20	SP5EWY	1,2,3,4,6,9,10,12,18,19,23,26,31,32
21	W8PAT	16,17,18,19,20,21,22,23,24,26,28,29,30,34,39
22	K4CKS	16,17,18,19,21,22,23,24,26,28,29,34,36,39
23	HB9RUZ	1,2,3,6,7,9,10,18,19,23,31,32
24	JA3IW	2,5,18,34,40
25	IK1GPG	1,2,3,6,10,12,18,19,23,32
26	W1AIM	16,17,18,19,20,21,22,23,24,26,28,29,30,34
27	K1LPS	16,17,18,19,21,22,23,24,26,27,28,29,30,34,37
28	W3NZL	17,18,19,21,22,23,24,26,27,28,29,34
29	K1AE	2,16,17,18,19,21,22,23,24,25,26,28,29,30,34,36
30	IW9CER	1,2,6,18,19,23,26,29,32
31	IT9IPQ	1,2,3,6,18,19,23,26,29,32
32	G4BWP	1,2,3,6,12,18,19,22,23,24,30,31,32
33	LZ2CC	1
34	K6MIO/KH6	16,17,18,19,23,26,34,35,37,40
35	K3KYR	17,18,19,21,22,23,24,25,26,28,29,30,34
36	YV1DIG	1,2,17,18,19,21,23,24,26,27,29,34,40
37	KØAZ	16,17,18,19,21,22,23,24,26,28,29,34,39
38	WB8XX	17,18,19,21,22,23,24,26.28,29,34,37,39
39	K1MS	2,17,18,19,21,22,23,24,25,26,28,29,30,34
40	ES2RJ	1,2,3,10,12,13,19,23,32,39
41	NW5E	17,18,19,21,22,23,24,26,27,28,29,30,34,37,39
42	ON4AOI	1,18,19,23,32
43	N3DB	17,18,19,21,22,23,24,25,26,27,28,29,30,34,36
44	K4ZOO	2,16,17,18,19,21,22,23,24,25,26,27,28,29,34
45	G3VOF	1,3,12,18,19,23,28,29,31,32
46	ES2WX	1,2,3,10,12,13,19,31,32,39
47	IW2CAM	1,2,3,6,9,10,12,18,19,22,23,27,28,29,32
48	OE4WHG	1,2,3,6,7,10,12,13,18,19,23,28,32,40
49	TI5KD	2,17,18,19,21,22,23,26,27,34,35,37,38,39
50	W9RPM	2,17,18,19,21,22,23,24,26,29,34,37
51	N8KOL	17,18,19,21,22,23,24,26,28,29,30,34,35,39
52	K2YOF	17,18,19,21,22,23,24,25,26,28,29,30,32,34
53	WA1ECF	17,18,19,21,23,24,25,26,27,28,29,30,34,36
54	W4TJ	17,18,19,21,22,23,24,25,26,27,28,29,34,39
55	JM1SZY	2,18,34,40
56	SM6FHZ	1,2,3,6,12,18,19,23,31,32
57	N6KK	15,16,17,18,19,20,21,22,23,24,34,35,37,38,40
58	NH7RO	1,2,17,18,19,21,22,23,28,34,35,37,38,39,40
59	OK1MP	1,2,3,10,13,18,19,23,28,32
60	W9JUV	2,17,18,19,21,22,23,24,26,28,29,30,34
61	K9AB	2,16,17,18,19,21,22,23,24,26,28,29,30,34
62	W2MPK	2,12,17,18,19,21,22,23,24,26,28,29,30,34,36
63	K3XA	17,18,19,21,22,23,24,25,26,27,28,29,30,34,36
64	KB4CRT	2,17,18,19,21,22,23,24,26,28,29,34,36,37,39
65	JH7IFR	2,5,9,10,18,23,34,36,38,40
66	KØSQ	16,17,18,19,20,21,22,23,24,26,28,29,34
67	W3TC	17,18,19,21,22,23,24,26,28,29,30,34
68	IKØPEA	1,2,3,6,7,10,18,19,22,23,26,28,29,31,32
69	W4UDH	16,17,18,19,21,22,23,24,26,27,28,29,30,34,39
70	VR2XMT	2,5,6,9,18,23,40
71	EH9IB	1,2,3,6,10,17,18,19,23,27,28
72	K4MQG	17,18,19,21,22,23,24,25,26,28,29,30,34,39
73	JF6EZY	2,4,5,6,9,19,34,35,36,40
74	VE1YX	17,18,19,23,24,26,28,29,30,34
75	OK1VBN	1,2,3,6,7,10,12,18,19,22,23,24,32,34
76	UT7QF	1,2,3,6,10,12,13,19,24,26,30,31
77	K5NA	16,17,18,19,21,22,23,24,26,28,29,33,37,39
78	I4EAT	1,2,6,10,18,19,23,32
79	W3BTX	17,18,19,22,23,26,34,37,38
80	JH1HHC	2,5,7,9,18,34,35,37,40.
81	PY2RO	1,2,17,18,19,21,22,23,26,28,29,30,38,39,40
82	W4UM	18,19,21,22,23,24,26,27,28,29,34,37,39
83	I5KG	1,2,3,6,10,18,19,23,27,29,32.
84	DF3CB	1,2,12,18,19,32
85	K4PI	17,18,19,21,22,23,24,26,28,29,30,34,37,38,39

Satellite Worked All Zones

No.	Callsign	Issue date	Zones Needed to have all 40 confirmed
1	KL7GRF	8 Mar. 93	None
2	VE6LQ	31 Mar. 93	None
3	KD6PY	1 June 93	None
4	OH5LK	23 June 93	None
5	AA6PJ	21 July 93	None
6	K7HDK	9 Sept. 93	None
7	W1NU	13 Oct. 93	None
8	DC8TS	29 Oct. 93	None
9	DG2SBW	12 Jan. 94	None
10	N4SU	20 Jan. 94	None
11	PAØAND	17 Feb. 94	None
12	VE3NPC	16 Mar. 94	None
13	WB4MLE	31 Mar. 94	None
14	OE3JIS	28 Feb. 95	None
15	JA1BLC	10 Apr. 97	None
16	F5ETM	30 Oct. 97	None
17	KE4SCY	15 Apr. 01	10,18,19,22,23, 24,26,27,28, 29,34,35,37,39
18	N6KK	15 Dec. 02	None
19	DL2AYK	7 May 03	2,10,19,29,34
20	N1HOQ	31 Jan. 04	10,13,18,19,23, 24,26,27,28,29, 33,34,36,37,39
21	AA6NP	12 Feb. 04	None
22	9V1XE	14 Aug. 04	2,5,7,8,9,10,12,13, 23,34,35,36,37,40
23	VR2XMT	01 May 06	2,5,8,9,10,11,12,13,23,34,40
24	XE1MEX	19 Mar. 09	2,17,18,21,22,23,26,34,37,40

CQ offers the Satellite Work All Zones award for stations who confirm a minimum of 25 zones worked via amateur radio satellite. In 2001 we "lowered the bar" from the original 40 zone requirement to encourage participation in this very difficult award. A Satellite WAZ certificate will indicate the number of zones that are confirmed when the applicant first applies for the award.

Endorsement stickers are not offered for this award. However, an embossed, gold seal will be issued to you when you finally confirm that last zone.

Rules and applications for the WAZ program may be obtained by sending a large SAE with two units of postage or an address label and $1.00 to the WAZ Award Manager: Floyd Gerald, N5FG, 17 Green Hollow Rd., Wiggins, MS 39577. The processing fee for all CQ awards is $6.00 for subscribers (please include your most recent *CQ* or *CQ VHF* mailing label or a copy) and $12.00 for nonsubscribers. Please make all checks payable to Floyd Gerald. Applicants sending QSL cards to a CQ Checkpoint or the Award Manager must include return postage. N5FG may also be reached via e-mail: <n5fg@cq-amateur-radio.com>.

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By Keith Pugh,* W5IU

SATELLITES

Artificially Propagating Signals Through Space

Working the "Easy Sats" with Portable Equipment: An Update

Over the years writing for *CQ VHF* I have touched on equipment to work the "Easy Sats" several times. However, I believe it is time to summarize this information and provide information on some new options that are now available. I will first discuss the basic modes of operation, and then the radios, and last the antennas.

The simplest satellite radio is a dual-band HT.

The Basic Modes of Operation

The FM satellites are perhaps the easiest satellites to work and require less, simpler equipment. Current popular FM satellites are AO-51, AO-27, SO-50, and the ISS (International Space Station). These satellites are channelized and have one or two channels per satellite. The satellites are crowded and can only accommodate one QSO per channel at a time. Consequently, QSOs are quite short (typically call and grid square only) and timing of a call is everything.

There are multiple uplink and downlink pairs on AO-51 and the ISS that are scheduled for operation one or two at a time. With a couple of minor exceptions, all operation is in FM mode. Doppler correction is much simpler due to the bandwidth of the FM equipment and the FM capture effect. Uplinks or downlinks above 2 meters must be Doppler corrected, but it can be done in as much as 5-kHz steps. You can get by without Doppler correction for 2 meters and below. Full-duplex operation is desirable, but not absolutely necessary. With full-duplex operation, you know you are "making the bird," since you can hear yourself on the downlink. This is good, unless you have no way of preventing feedback of the downlink audio into the uplink. Headphones will prevent this feedback, or careful placement of the speaker and adjustment of downlink audio level will minimize it. For demonstrations, I find using a half-duplex radio, such as the Yaesu FT-817, is very satisfactory.

For the SSB/CW satellites, it is essential to operate full duplex so that you can hear yourself and keep Doppler precisely under control. Current popular SSB/CW satellites are AO-07, FO-29, and VO-52. These satellites have linear transponders with at least a 50-kHz wide passband. Several QSOs can simultaneously take place within the passband and a good, old-fashioned "rag chew" is possible and encouraged.

Full-duplex operation is essential so that you can keep the narrower uplink and downlink signals on the same frequency by hearing yourself and the other stations on the downlink at the same time. Computer control of the uplink and downlink is nice, but not essential. One exception to the full-duplex rule is possible if you do have computer control of the radio. However, I find this less than satisfactory. Operation is typically done using a full-duplex radio or two half-duplex radios. For demos, I typically use two Yaesu FT-817s and find them very satisfactory. Many other combinations are possible and will be discussed under "Radios" below.

Radios

The simplest satellite radio is a dual-band HT (handie-talkie). Another option is two separate single-band HTs. A transmit power level of at least 5 watts is desirable but not absolutely necessary. As mentioned above, full-duplex capability is desirable. Popular HTs that are full duplex are the Yaesu FT-530, the ICOM IC-W32A, and the Kenwood TH-D7. Unfortunately, none of these radios is in current production. Alinco introduced a new full-duplex, dual-band, HT at the Dayton Hamvention® this year and it is

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looking good so far, but the "jury is still out." Two separate single-band radios are inherently full duplex.

Many dual-band, half-duplex radios are available and are satisfactory if they can be operated in split mode and can store split-mode channels in memory. Examples of this type of radio are the following: Yaesu VX-5R and FT-60R, ICOM IC-T90A, and Kenwood TH-F6A. Many additional radios are available, as well.

As mentioned before, full-duplex operation is essential for SSB/CW operation, as are multimode radios. Current production multimode base-station radios that are at least dual band and full duplex are the ICOM IC-910H and the Kenwood TS-2000. In keeping with the portable equipment theme, only a few of the radios fit the multimode theme and none of them are full duplex. What this means is you generally will need two radios to satisfy the full-duplex requirement. I use two Yaesu FT-817s very successfully, but I could just as easily use one of the FT-817s and my ICOM IC-7000 as a pair. Another good portable choice would be the Yaesu FT-857 paired with an FT-817 or almost any other multi-band, multimode radio. The sky is the limit here. You could even use HF-only equipment with converters to satisfy the requirements.

Another option is to use a multimode receiver and a multimode transceiver. For example: I have used one of my FT-817s

One of the popular HTs that is full duplex is the Yaesu FT-530, which, however, is not in current production.

Regarding portable equipment, only a few of the radios fit the multimode theme and none of them are full duplex. Therefore, you generally will need two radios to satisfy the full-duplex requirement. I use two Yaesu FT-817s very successfully.

Another option is to use a multimode receiver and a multimode transceiver. I have used one of my FT-817s along with either an ICOM IC-R20 or a Yaesu VR-500 portable receiver.

along with either an ICOM IC-R20 or a Yaesu VR-500 portable receiver. An additional popular multimode receiver to pair with a multimode transceiver is the Kenwood TH-F6A. Some of these combinations may require receive pre-amps for satisfactory service and some of them may suffer in high-RF environments. Doing demos at Dayton the last several years has allowed me to zero-in on the two FT-817s as my best portable choice. They survive the Dayton RF environment well and do not require external pre-amps with short cable lengths, and typical antennas that will be discussed below.

Portable Antennas

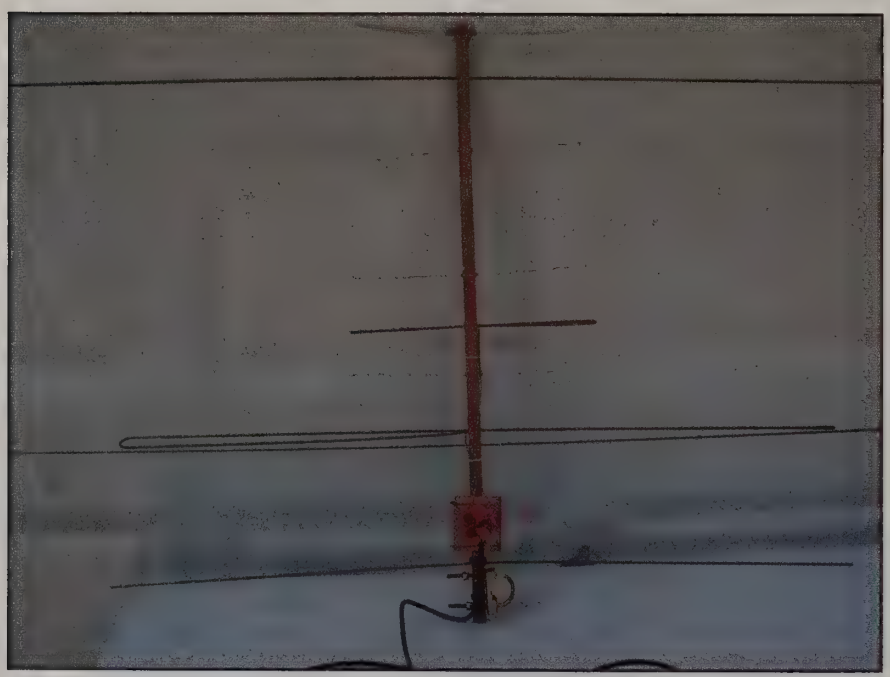
Four popular antennas fit the portable category. They will be discussed individually below.

Kent Britain, WA5VJB, popularized the Cheap LEO antennas in a magazine article several years ago, and since then they have been duplicated successfully worldwide by many operators. Personally, I find these antennas very satisfactory for all portable satellite work. I generally use the two-band antenna with a diplexer for FM satellites and separate 2-meter and 70-cm antennas for the SSB/CW birds. The antennas are very light and easy to hold, since they are made of wood, aluminum wire, and brass welding-rod materials. They are not as easy to disassemble and transport as some of the commercial designs. However, one could improve on this with some innovations. The homemade diplexer can handle several watts of RF and could be used at higher levels with higher voltage capacitors. Of course, these antennas can be fed directly (without the diplexer) at any practical power level.

The Arrow Antenna gets its name from its construction. The elements are made from aluminum arrow shafts. This antenna has been around a long time and is very popular. It is light and easy to use. It can also be disassembled and stored in a small bag for transport. I have taken one with me worldwide in my suitcase. It can handle a lot of power if fed directly or through an external diplexer. Using the diplexer in the handle, it is limited to 10 watts. However, that is not a big handicap.

Qualitatively, I believe the WA5VJB Cheap LEO antennas will out perform the Arrow, but I have used my Arrow successfully for many contacts and demos.

The Elk Antenna is a log-periodic design that works quite well on both bands. It looks like it is only a 2-meter antenna, but it takes advantage of the 3/2-wavelength mode for 70 cm. Since it is only a single feed, it does not require a diplexer and can handle a lot of RF power. This antenna also uses aluminum arrow shafts for its elements. The boom and other framework are aluminum and plastic PVC pipe. It can be disassembled and stored in a small bag. In handheld applications, it is heavier than the Arrow and other antennas, making it a little tiresome to hold. This antenna has not been on the market as long as the Arrow, but it looks and performs like a winner. I like to use it on a Cheap Az-El positioner and an external diplexer to work the SSB/CW birds. The diplexer, in this case, is used to connect the Elk Antenna to my two FT-817s.



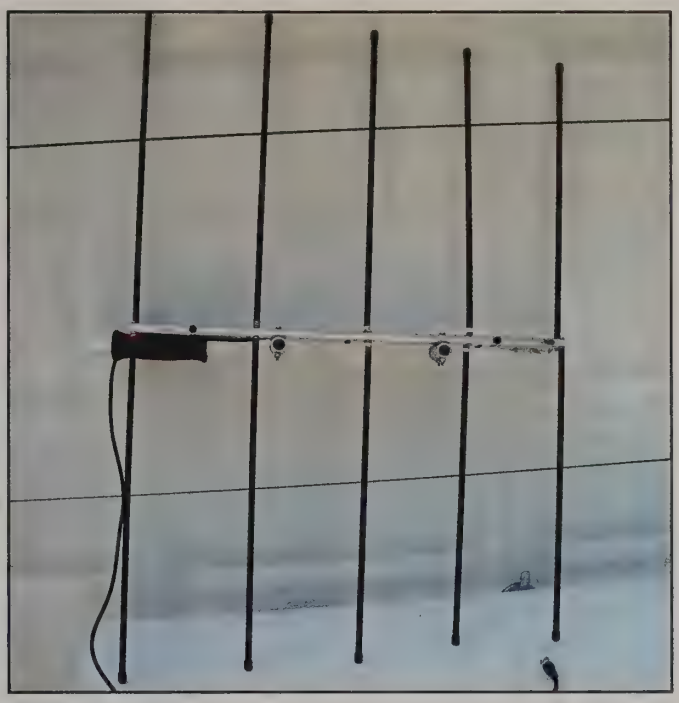
Kent, WA5VJB's Cheap LEO antenna. I find these antennas very satisfactory for all portable satellite work.

Traditional "rubber ducks" are not recommended. However, several "high gain" verticals can be used successfully with additional patience and skill. The skill comes with the ability to use metal plates (such as car hoods) or the ground as reflectors. I have used the MFJ-1717 successfully on a number of occasions. These antennas work, but should not be considered a substitute for one of the handheld beams.

Field Day

Once again we have proven that the FM birds are not a good match for Field Day. Even with the "One Contact per FM

The Arrow Antenna elements are made from aluminum arrow shafts. This antenna has been around a long tim and is light and easy to use



The Elk Antenna is a log-periodic design that works quite well on both bands 2-meters and 70 cm.

Transponder Rule" it is extremely difficult to break into the FM pile-ups. Operation on the SSB/CW birds was much more successful. We had a good time at W5IU with the Lockheed Martin ARC and the Fort Worth Kilocycle Clubs joint operation.

This year I moved my portable operation over to a newer notebook computer running Windows® Vista and no RS-232 serial ports. I also upgraded to SatPC32 Version 12.8. After some difficulty finding and installing a USB to four serial port converter and a missing .dll file for the LabJack Rotor Control, everything is working satisfactorily and was used throughout Field Day. I did have one problem during Field Day with up conversion of one of my FT-817s to L-Band with SatPC32. After Field Day, the author of the program, Erich Eichmann, DK1TB, verified and fixed the problem with a patched file within 24 hours after reporting the problem. Excellent response time!

Summary

I attended a meeting 17–19 June in the Netherlands hosted by the European Space Agency (ESA). This was a very productive meeting and will be discussed in a future column.

I hope this column has given everyone some additional insight into working the "Easy Sats" and the equipment options available.

Don't forget to help celebrate the 40th Anniversary of AMSAT in Baltimore, Maryland, 8–12 October 2009. Actually, the AMSAT BOD Meeting is 8–9 the Space Symposium is 9–11, and the ARISS-Ops "Face-to-Face Meeting is 11–12.

Please support AMSAT in its fund raising efforts so that they can continue to put more "birds" on the air. Until next time!

73, Keith, W5IU

By Tomas Hood,* NW7US

VHF PROPAGATION

The Science of Predicting VHF-and-Above Radio Conditions

Solar Cycle 24 – Expectations

How much credibility should we grant to the panel of solar researchers and scientists that again releases a speculative prediction of the new solar cycle (the 24th since accurate solar cycle records have been kept)? Panel chairman Doug Biesecker of the NOAA Space Weather Prediction Center states, "If our prediction is correct, solar Cycle 24 will have a peak sunspot number of 90, the lowest of any cycle since 1928 when solar Cycle 16 peaked at 78."

NASA's lead representative on the panel, Dr. Dean Pesnell of the Goddard Space Flight Center, adds, "It turns out that none of our models were totally correct.... The sun is behaving in an unexpected and very interesting way."

What I find entertaining is the self-importance prevalent in the solar science community by both professional and some amateur participants. Pesnell states the obvious, "In our professional careers, we've never seen anything quite like it."

Yes, how many solar cycles can one experience during one's professional life? The average cycle lasts between 11 and 12 years. However, the sun is millions of years old. In my view, it is pretty arrogant to postulate that mankind has any real understanding of and handle on what the sun might do next. Pesnell, again: "Go ahead and mark your calendar for May 2013, but use a pencil."

No one can postulate with any credibility just how intense the new cycle will be, because there's no direct correlation between this solar minimum and any regular pattern of past minimums. In 2008 and 2009, the sun was quieter than during any period during the "Space Age" (again, a very short time of reference in relation to the millions of years of solar history). During the last two years we've seen low sunspot counts, weak solar wind, low solar irradiance, and a period without a significant solar flare.

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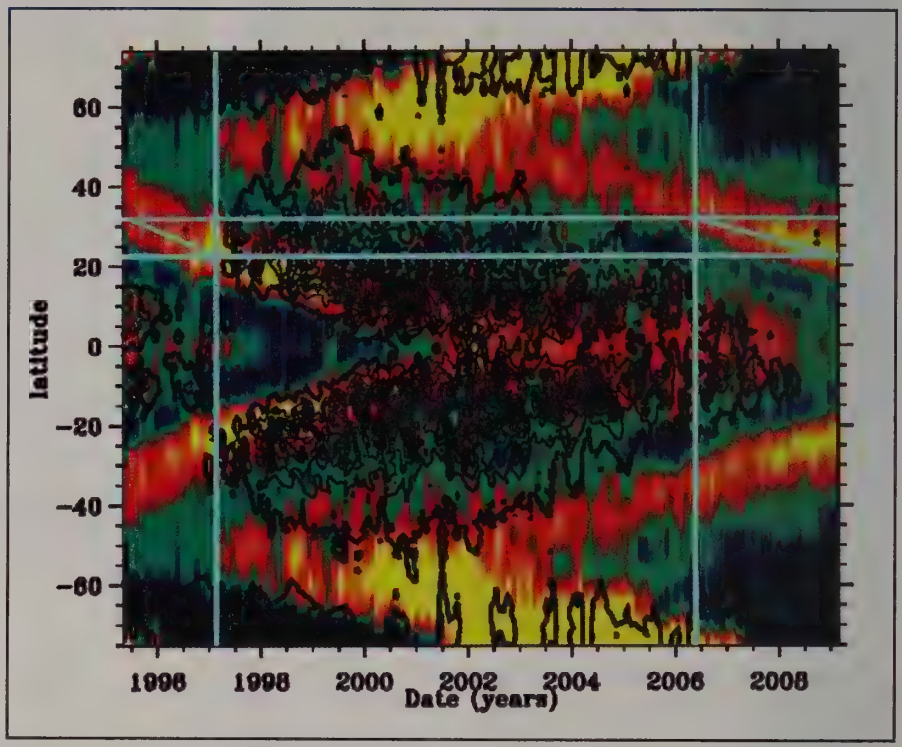
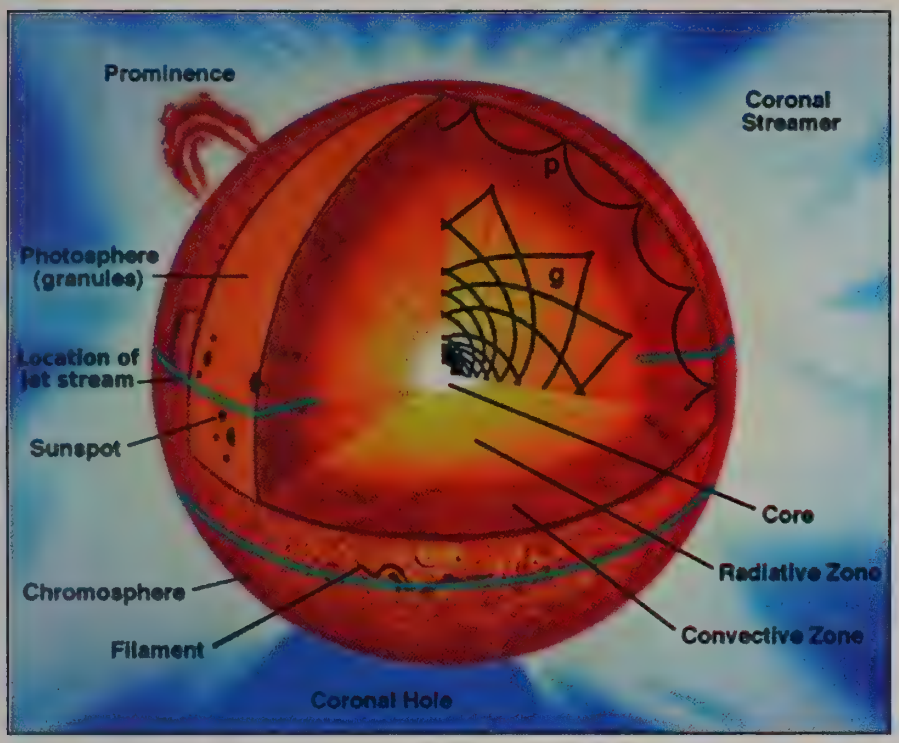


A helioseismic map of the solar interior. Tilted red-yellow bands trace solar jet streams. Black contours denote sunspot activity. When the jet streams reach a critical latitude around 22 degrees, sunspot activity intensifies. (Source: National Solar Observatory [NSO] in Tucson, Arizona)

If none of the models is totally correct, how are they making this current prediction with such dismal expectations? At this point, I'm not holding my breath in favor of supporting any of the predictions. With the slow, yet sure increase in solar activity during recent months as seen with the emergence of more frequent small sunspots (many of which are new cycle spots) and "proto-sunspots," there is hope that the sun is finally awakening. Tiny but significant increases in solar radio emissions are being observed, as well. Further evidence that the sun is experiencing an increase in solar cycle activity is the "zonal flows" (enormous currents of plasma on the sun's surface) that are gaining strength and slowly drifting toward the sun's equator. All of these things are precursors of an awakening solar Cycle 24. The evidence is clear; we are seeing a real start of Cycle 24.

The Sun's Jet Stream

Speaking of the "zonal flows," did you know that the sun has jet streams? Recent research now reveals a powerful dynamic deep inside the sun. Scientists from the National Solar Observatory (NSO) in Tucson, Arizona have discovered that deep inside the sun a powerful solar jet stream migrates through the star's interior. During this current solar cycle minimum, this solar jet stream moved more slowly than in recent past minimum periods. This appears to be the underlying reason for the long period that lacked



This diagram of the sun's internal structure shows the sun's major parts, including the jet streams that arediscussed in the text. The jet streams extend deep into the sun, to the base of the solar convective zone. (Source: NASA)

sunspots and prolonged the solar minimum. The scientists involved in this discovery presented their research at the meeting of the Solar Physics Division of the American Astronomical Society (AAS/SPD) in June 2009.

Drs. Rachel Howe and Frank Hill, both of the NSO, used long-term observations from the NSO's Global Oscillation Network Group (GONG) facility to detect and track an east-to-west jet stream, known as the "torsional oscillation," at depths of about 1000 to 7000 km below the surface of the sun. The sun generates new jet streams near its poles every 11 years; the streams migrate slowly, over a period of 17 years, to the equator and are associated with the production of sunspots once they reach a critical latitude of 22 degrees.

Howe and Hill found that the stream associated with the new solar cycle has moved sluggishly, taking three years to cover a 10-degree range in latitude, compared to two years for the last solar cycle, but has now reached the critical latitude. The current solar minimum has become so long and deep that some scientists have speculated the sun might enter a long period with no sunspot activity at all. The new result shows both that the sun's internal magnetic dynamo continues to operate and heralds the beginning of a new cycle of solar activity.

"It is exciting to see," said Dr. Hill, "that just as this sluggish stream reaches the usual active latitude of 22 degrees, a year late, we finally begin to see new groups of sunspots emerging at the new active latitude." Since the current minimum is now one year longer than usual, Howe and Hill conclude that the extended solar minimum phase may have resulted from the slower migration of the flow.

GONG and its sister instrument, SOHO/MDI (Solar and Heliospheric Observatory/Michelson Doppler Imager), measure sound waves on the surface of the sun. Scientists can then use the sound waves to probe structures deep in the interior of the star in a process analogous to a sonogram in a medical office. "Using the global sound-wave inversions, we have been able to reveal the intimate connection between subtle changes in the sun's interior and the sunspot cycle on its surface," said Hill.

"This is an important piece of the solar activity puzzle," said Dr. Dean Pesnell. "It shows how flows inside the sun are related to the creation of solar activity and how the timing of the solar cycle might be produced. None of the forecasting research groups predicted the current long, extended delay in the new cycle. There is a lot more to learn in order to understand how the sun creates magnetic fields."

The new science of helioseismology, enabled by instruments such as the ground- based GONG, the Michelson Doppler Imager aboard the SOHO spacecraft, and NASA's planned Solar Dynamics Observatory, has revolutionized understanding of the solar interior. "While the surface effects of the sun's torsional oscillations have been observed for some time, understanding of the dynamo and the origin of sunspots depends on measurements of the solar interior that are only possible with helioseismic techniques," said Hill.

Sunspot Group 1024

Now that this solar jet stream has reached the "critical" latitude, are we seeing a rise in the number of sunspots? Yes, and the period between sunspot emergences is becoming shorter and shorter. For instance, during the month of June 2009, sunspots were observed on 13 days of the month. Then, starting on July 3, another new Cycle 24 sunspot emerged, daily growing in size and unleashing numerous flares. By the 4th of July, and for the first time in the new cycle, a C-class flare erupted (it was encouraging to see solar fireworks on Independence Day!). By July 6th, it was clear that this sunspot group was influencing radio propagation, as the 10.7-cm flux rose above 70, and subtle changes in various modes of propagation were observed. This sunspot group comes as part of a series of new sunspots, indicating that the new cycle is certainly alive and gaining in strength.

As this new cycle gains energy, which is clearly occurring, a rise is interplanetary storms and a resulting increase in geomagnetic activity will trigger a livelier autumnal auroral season this year. With the autumnal equinox occurring on September 22, 2009, the chance for auroral activity in the weeks leading up to and the weeks after the equinoctial event will be higher than during the last few years.

Perseids Meteor Shower

Regardless of what the sun is doing, VHF radio enthusiasts can count on

working meteor showers. One of the most reliable yearly meteor showers is the *Perseids*. The *Perseids*, like other meteor showers, is named after the constellation from which it first appeared to have come. This shower's constellation is Perseus, which is located near Cassiopeia. *Perseids* favor northern latitudes. Because of the way Comet Swift-Tuttle's orbit is tilted, its dust falls on Earth's Northern Hemisphere. Meteors stream out of the constellation Perseus, which is barely visible south of the equator.

Lewis Swift and Horace Tuttle, Americans working independently, discovered a comet in August 1862. Three years later, Giovanni Schiaparelli (of Martian "canali" fame) realized it was the source of the August *Perseids* meteors. The comet, known now as Comet Swift-Tuttle, leaves a trail of dust that Earth passes through during August.

This year the shower will be active from mid-July through late August. The peak is expected to be on August 12. The number of visual meteors is expected to be as high as 100 per hour. Visually, this shower will be difficult to enjoy due to the bright moon, but it is possible, using high-speed CW, to realize a higher hourly rate. Many meteors that are not visible might contribute to the ionization necessary for long-distance contacts.

The *Perseids* shower begins slowly in mid-July, featuring dust-sized meteoroids hitting the atmosphere. As we get closer to August 12, the rate builds. For working VHF/UHF meteor scatter, this could prove to be an exciting event.

The best time for working the *Perseids* VHF/UHF meteor scatter in North America is during the hours before dawn, as early as midnight, but more likely peaking after 2:00 AM until about 5:00 AM local time.

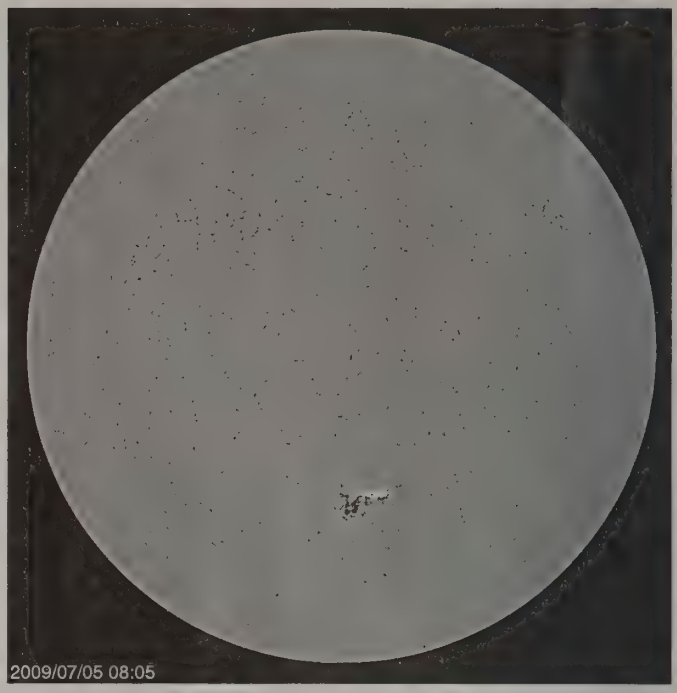
Other Meteor Showers of Summer and Early Fall

Look for the *Draconids,* a primarily periodic shower that produced spectacular, brief meteor storms twice in the last century, in 1933 and 1946. Most recently, in 2005, we saw the stream's parent comet, 21P/Giacobini-Zinner, returning to perihelion. This year's peak is expected to occur on October 8 at 1640 UTC. The shower should be active from October 6 through October 10. The *Draconids* meteors are exceptionally slow-moving, a characteristic that helps separate genuine shower meteors from sporadics accidentally lining up with the radiant. This is a good shower to work meteor-scatter mode, since we might see storm-level activity this year. For more information, take a look at <http://www.imo.net/calendar/2009>.

The Solar Cycle Pulse

The observed sunspot numbers from March through May 2009 are 0.7, 1.2, and 2.9. Notice that the record of 0.8 for December 2008 is higher than the 0.5 recorded for both July and August of 2008. It would appear that August 2008 is the lowest point of the minimum between Cycle 23 and Cycle 24. However, scientists are now saying that statistically, December 2008 was the mathematically lowest point in the solar cycle minimum between Cycles 23 and 24. The smoothed sunspot counts for September, October, and November 2008 are 2.2, 1.8, and 1.7, respectively.

The monthly 10.7-cm (preliminary) numbers from March through May 2009 are 69.2, 69.7, and 70.6. The smoothed 10.7-



The magnetograph image from July 5, 2009 showing sunspot group 1024. This Cycle 24 sunspot group unleashed a number of flares, providing solar fireworks for the 4th of July. This new activity is indicative of the long-awaited recent rise in sunspot activity. (Source: NASA/SOHO)

An EIT (Extreme ultraviolet Imaging Telescope) image of sunspot group 1024 in the Fe XII emission line at 195 wavelength. Fe XII (Fe = iron; 11 times ionized Fe) is common at temperatures of 1.5 million K. Note the huge magnetic field lines between sunspots. This sunspot group unleashed the largest flare yet recorded (at press time) in the new solar cycle, Cycle 24. (Source: NASA/SOHO)

cm radio flux numbers for September through November 2008 are 68.4, 68.2, and 68.3.

The smoothed planetary *A*-index (*Ap*) numbers for September through November 2008 are 5.8, 5.4, and 5.1. The monthly readings for March through May 2009 are 4 for each month.

The smoothed monthly sunspot numbers forecast for August through October 2009 are 8.0, 9.6, and 11.4. These predictions, however, may be too pessimistic, as they are based on the May 2009 forecast which postulates a solar cycle maximum only reaching a smoothed sunspot count of 90.

The smoothed monthly 10.7 cm is predicted to be 69.5, 70.4, and 71.3 for the same months. If we accept these numbers, we still see that Cycle 24 is upon us.

(Note that these are preliminary figures. Solar scientists make minor adjustments after publishing, by careful review).

Feedback, Comments, Observations Solicited!

How is your sporadic-*E* season this year? Arthur Jackson, KA5DWI, has been carefully crunching numbers obtained by his activity in PropNET (http://www.propnet.org/) over the past five years. Art, a record-holder in the North American DX Records listings on 2-meter tropo, discusses his research with me in the new "NW7US Space Weather and Radio Propagation Podcast." He explains that the *Es* season in 2009 has been better than any of the past four years. He observes that this is in part due to the very quiet geomagnetic activity during this prolonged solar minimum. Listen to the podcasts by browsing to <http://podcast.hfradio.org/>. In the next issue *CQ VHF* we will take a more in-depth look at this year's sporadic-*E* season and Art's research.

I am looking forward to hearing from you about your observations of VHF and UHF propagation. Please send your reports to me via e-mail, or drop me a letter about your VHF/UHF experiences (sporadic-*E*, meteor scatter?). I'll create summaries and share them with the readership. I look forward to hearing from you. Up-to-date propagation information is found at my propagation center at <http://prop.hfradio.org/> and via cell phone at <http://wap.hfradio.org/>.

Until the next issue, happy weak-signal DXing.

73 de Tomas, NW7US

Advertisers' Index

QUARTERLY CALENDAR OF EVENTS

Current Contests

August: There are two important contests this month. The **ARRL UHF and Above Contest** is scheduled for August 1–2. The first weekend of the **ARRL 10 GHz** and above cumulative contest is scheduled for August 15–16.

September: The **ARRL September VHF QSO Party** is September 12–14. The second weekend of the **ARRL 10 GHz** and above cumulative contest is September 19–20. The following are the dates for the **Fall Sprints**: The **144 MHz Fall Sprint** is September 21, 7 PM to 11 PM local time. The **222 MHz Fall Sprint** is September 29, 7 PM to 11 PM local time.

October: The **432 MHz Fall Sprint** is October 7, 7 PM to 11 PM local time. The **Microwave (902 MHz and above) Fall Sprint** is October 17, 6 AM to 12 PM local time. The **ARRL 50 MHz to 1296 MHz EME Contest** is October 10– 11. The **50 MHz Fall Sprint** is October 24, 2300 UTC to October 25, 0300 UTC.

November: The **ARRL 2.3 GHz and UP EME Contest** is November 7–8.

For ARRL contest rules, see the issue of *QST* prior to the month of the contest or the URL: <http://www.arrl.org>. For Fall Sprint rules, see the Southeast VHF Society URL: <http://www.svhfs.org>.

Quarterly Calendar

The following is a list of important dates for EME enthusiasts:

Aug. 2	Very poor EME conditions.
Aug. 4	Moon apogee.
Aug. 6	Full Moon.
Aug. 6	Lunar eclipse.
Aug. 9	Moderate EME conditions.
Aug. 12	*Perseids* Meteor Shower.
Aug. 13	Moon last quarter.
Aug. 16	Poor EME conditions.
Aug. 19	Moon perigee.
Aug. 20	New Moon.
Aug. 23	Good EME conditions.
Aug. 27	Moon first quarter.
Aug. 30	Very poor EME conditions.
Aug. 31	Moon apogee.
Sept. 4	Full Moon.
Sept. 6	Moderate EME conditions.
Sept. 12	Moon last quarter.
Sept. 13	Poor EME conditions.
Sept. 16	Moon perigee.
Sept. 18	New Moon.
Sept. 20	Moderate EME conditions.
Sept. 22	Fall equinox.
Sept. 26	Moon first quarter.
Sept. 27	Very poor EME conditions.
Sept. 28	Moon apogee.
Oct. 4	Full Moon. Moderate EME conditions.
Oct. 11	Moon last quarter. Moderate EME conditions.
Oct. 13	Moon perigee.
Oct. 18	New Moon. Moderate EME conditions.
Oct. 21	*Orionids* meteor shower.
Oct. 25	Moon apogee. Very poor EME conditions.
Oct. 26	Moon first quarter.
Nov. 1	Moderate EME conditions.
Nov. 2	Full Moon.
Nov. 7	Moon perigee.
Nov. 8	Good EME conditions.
Nov. 9	Moon last quarter.
Nov. 15	Moderate EME conditions.
Nov. 16	New Moon.
Nov. 17	*Leonids* meteor shower.
Nov. 22	Moon apogee. Poor EME conditions.
Nov. 24	Moon first quarter.
Nov. 29	Moderate EME conditions.

—EME conditions courtesy W5LUU

Current Conferences and Conventions

September: The 2009 **TAPR/ ARRL Digital Communications Conference** will be held September 25–27 in Chicago, Illinois, at the Holiday Inn Hotel Elk Grove Village, Illinois. For more information, see the URL: <http://www.tapr.org/dcc.html>.

October: The 2009 **Microwave Update** conference is to be held October 23–24 in Irving, Texas at the Westin, DFW Airport. For further information, check the Microwave Update website: <http://www.microwaveupdate.org>.

The 2009 AMSAT-NA Space Symposium and Annual Meeting is to be held October 9–11, in Baltimore, Maryland at the Four Points Sheraton Hotel. For more information, see the AMSAT URL pertaining to the symposium at: <http://www.amsat.org/amsat-new/symposium/2009/index.php>.

Calls for Papers

Calls for papers are issued in advance of forthcoming conferences either for presenters to be speakers, or for papers to be published in the conferences' *Proceedings*, or both. For more information, questions about format, media, hardcopy, e-mail, etc., please contact the person listed with the announcement. The following organizations or conference organizers have announced a call for papers for its forthcoming conference:

Microwave Update: A call for papers has been issue for the 2009 Microwave Update conference, to be held in Irving, Texas. The deadline for submission is August 31. If you are interested in submitting a paper for publication in the *Proceedings*, please contact Kent Britain, WA5VJB, at <wa5vjb@flash.net> for additional information.

AMSAT-NA 2009 Space Symposium: Technical papers are solicited for the 2009 AMSAT Space Symposium and Annual Meeting to be held October 9–11 in Baltimore, Maryland. Proposals for papers, symposium presentations, and poster presentations are invited on any topic of interest to the amateur satellite program. Papers on the following topics are solicited: Students & Education, ARISS, AO-51, P3E, Eagle, and other satellite-related topics.

Camera ready copy on paper or in electronic form will be due by the date announced on the website <http://www.amsat.org> for inclusion in the printed symposium *Proceedings*. Papers received after this date will not be included in the printed proceedings. Abstracts and papers should be sent to the name listed in the announcement on the website.

Meteor Showers

August: Beginning around July 17 and lasting until approximately August 24, you will see activity tied to the *Perseids* meteor shower. Its predicted peak is around 1730–2000 UTC on August 12. A possible tertiary peak may occur around 0900 UTC. The *κ-Cygnids* meteor shower is expected to peak on August 17. The visually-impossible *γ-Leonids* is expected to peak August 25, around 0400 UTC. The *α-Aurigids* is expected to peak on August 31.

October: The *Draconids* is predicted to peak somewhere around 1640 UTC on October 8. The predicted ZHR may reach storm levels. The *Orionids* is predicted to peak on October 21.

November: The *Leonids* is predicted to peak around 1715 UTC on November 17. As with last year's shower, this year's peak may go largely unnoticed.

For more information on the above meteor shower predictions see Tomas Hood, NW7US's VHF Propagation column in this issue. Also visit the International Meteor Organization's website: <http://www.imo.net/calendar/2009>.

By Dr. H. Paul Shuch,* N6TX

DR. SETI'S STARSHIP

Searching For The Ultimate DX

The Bet is Already Won

In our last column in the Spring 2009 issue of *CQ VHF*, we introduced Long Bets (www.longbets.org), the Arena for Accountable Predictions, a web-based wagering facility launched by the futures-oriented Long Now Foundation. The purpose of Long Bets is to improve long-term thinking. You may recall that Long Bets is a public arena for enjoyably competitive predictions, of interest to society, with philanthropic money at stake. As mentioned in that column, I am a party to one of those bets—and so, it turns out, are a couple of my colleagues.

Their wager is intriguing. It was proposed by Tibor Pacher, who runs the Peregrinus Interstellar website, and the challenge was accepted by Paul Gilster of Centauri Dreams. Since both parties to the wager are friends of The SETI League, I felt compelled to follow the debate closely.

The bet in question, as posted by Pacher, reads: "The first true interstellar mission, targeted at the star closest to the sun or even farther, will be launched before or on December 6, 2025 and will be widely supported by the public."

The conditions to be satisfied in winning this bet are quite specific:

1. The mission can be a manned or unmanned flyby probe or to be captured by the target star's gravitational field. It will have been designed expressly as a mission to another star, and not an outer-solar-system mission that keeps going.

2. Allowed launch location of the spacecraft is any place in the solar system within the orbit of Neptune, either from the surface of a solar system body or from any orbital position.

3. As a minimum requirement for the mission the spacecraft shall be capable of delivering data for at least one scientific measurement.

4. Planned mission duration shall be less than 2,000 years.

Gilster is arguing against Pacher's prediction, but it seems to me that the bet has already been won. I would argue that the first interstellar missions have already launched and that (exercising only a little imagination) they meet the above conditions. Those missions involve not spacecraft, but rather streams of photons, the fastest spaceships known to man.

Think about it: Interstellar microwave transmissions probe other civilizations' interest in dialog and pass numerous stars, and thus are "flyby probes," in a sense. They are transmitted specifically for the purpose of reaching other solar systems. They have been "launched" (transmitted) several times from Earth, which is clearly within the 4.5-billion km radius of Neptune's orbit. Some of these transmissions have conveyed scientific information about Earth, which satisfies the condition that they "deliver data for at least one scientific measurement." They travel at the speed of light, so within the 2,000-year mission duration they potentially will reach thousands of stars within 2,000 light years of our own sun. Also, they are widely supported by the public, as witnessed by the large number of humans who have submitted messages to the various projects that beam them into space. Thus, congratulations, Tibor, you win!

Nevertheless, Tibor and Paul agree that what they had in mind is slightly larger interstellar probes. They also had intended provision #3 to require the delivery of scientific data *to,* not *from,* Earth, although they failed to state this clearly in their wager. Thus, honoring the spirit (if not the language) of the bet, I guess we'll have to wait a little longer to see whose position prevails.

Meanwhile, as a side bet, Tibor and Paul have agreed that the loser will buy the winner a beer, probably in Budapest (Tibor's native town, and a favorite venue of Paul's and mine), once the bet is decided. They've invited me to join them there on December 6, 2025, win or lose. Since I hope still to be drinking beer into my eighties, I look forward to doing so, and to reporting the outcome of this wager in Volume 28, Issue No. 1 of *CQ VHF*. So, don't let your subscription lapse!

73, Paul, N6TX

*Executive Director Emeritus, The SETI League, Inc., <www.setileague.org>
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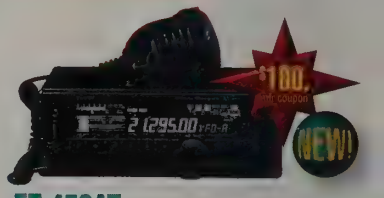

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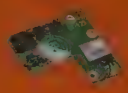

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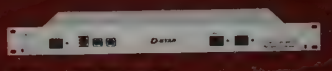

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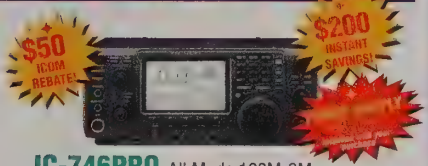

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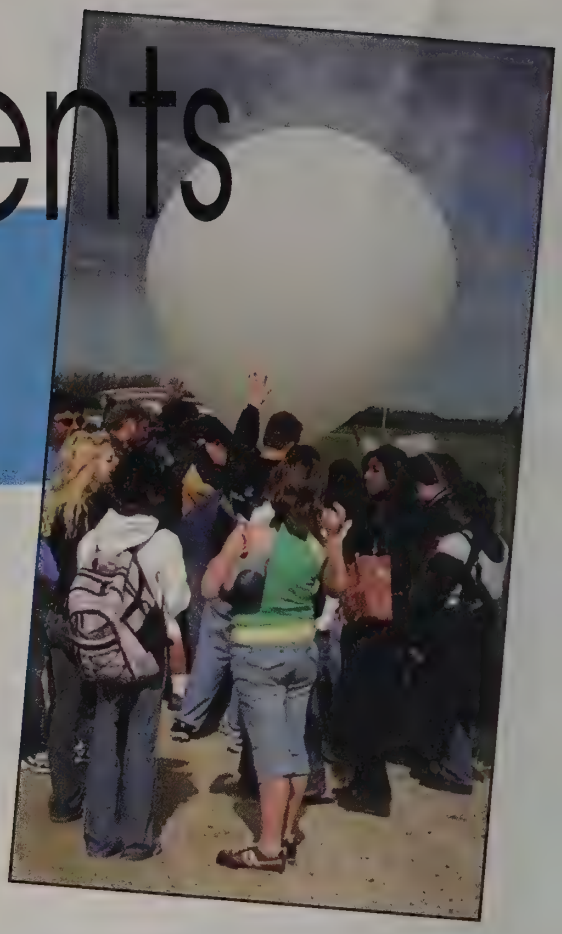

Winter 2009
Vol. 12 No. 4

FEATURES

COLUMNS

DEPARTMENTS

On The Cover: The major 2008 expedition from above the Alaskan Arctic Circle. For details, see the article "Riding the Terminator from 6 Meters Down to 160 Meters," by WB6NOA and KL7BB, beginning on page 24.

CQ VHF Ham Radio Above 50 MHz

LINE OF SIGHT

A Message from the Editor

My Wish List for the New Administration

By the time you read this editorial, the new presidential administration will have been in office for less than a month. In my estimation, it is just about the right time for the leadership to receive suggestions for future developments that will further and enhance our hobby's capabilities to meet the demands of our national interest. Below, you will read my wish list for the new administration.

NASA and the U.S. Department of Education

This past November the U.S. Department of Education (DOEd) invited the Amateur Radio on board the International Space Station (ARISS) organization to help celebrate the ninth annual International Education Week (IEW) by coordinating three contacts with the International Space Station (ISS) during IEW, November 17–21. This invitation came, according to ARRL ARISS Project Manager Rosalie White, K1STO, after the DOEd had been tracking ARISS's activities for a long time. The joint venture, which also included NASA and the Department of State, was a resounding success. Among the outcomes were both international goodwill and encouraging scientific education among school students. For more information on the project, go to <http://www.arrl.org/news/stories/2008/ 12/02/10489>.

It is my wish that such programs continue and be expanded. Additionally, it is my wish to see more federal funding directed toward NASA's education programs, such as NASA's Space Grant Consortium. Regular readers of this magazine have already read articles about amateur radio related projects that are being run under the auspices of various colleges and universities across the country. These programs have proven to be sources of producing new amateur radio operators. Regarding these programs, it is my wish that NASA assign an employee full time to publicize projects that are being carried out at various state space grant consortia around the country.

Concerning NASA and education, a paltry few of its programs are reaching down to the common school level. In particular, programs need to be developed that reach the elementary and middle-school levels. Any education administrator will tell you that if you have not captured a student's imagination by the early middle-school years, you run a high risk of losing that student's lifetime positive creativity. Therefore, it is my wish that Congress and the President approve and authorize increased funding to NASA for education-related projects.

FEMA

In the aftermath of the devastating hurricanes and other natural disasters in recent years, regarding communications, FEMA has begun to get its act together. FEMA and the military, along with state and local agencies, are making great strides toward solving interoperability problems.

However, while the government organizations are learning how to effectively communicate with one another, the non-government organizations (NGOs) are beginning to be left behind. While many of us have seen examples of communications vans, trailers, and trucks being operated in the field by the Red Cross, Salvation Army, and the Southern Baptist Hams, these organizations represent only a small fraction of the many NGOs that FEMA has begun to rely upon for disaster recovery work.

For example, the United Methodist Committee on Relief (UMCOR) has been tasked by FEMA to handle $66 million that the U.S. government received from foreign governments in the aftermath of Hurricane Katrina. While this may seem like a lot of money, FEMA restricts its use to direct assistance to those who qualify for such assistance.

What is lacking for UMCOR and other NGOs is a communications infrastructure that is needed by these organizations when they are tasked by FEMA to respond to disasters. While FEMA has the money it needs for solving its communications problems, these NGOs rely on private contributions to fund items such as emergency radio equipment, emergency operations centers (EOCs), as well as radio-equipped emergency vehicles. It is my wish that FEMA find a way to help these NGOs fund their emergency communications equipment needs—preferably through private sources. It is also my wish that FEMA supply expert telecommunications advisors to these NGOs in their efforts to establish their communications infrastructures.

ITAR

Of ongoing concern to experimenters in our hobby is the International Traffic in Arms Regulations (ITAR). Within the amateur radio experimenting community is a growing "ITAR paranoia" as Bill Ress, N6GHZ, comments in his paper "ITAR and AMSAT," which was published in the *Proceedings* of the 2008 AMSAT Symposium. More than one experimenter has walked away from the research and development tables at AMSAT-NA as a result of ITAR paranoia. In particular, cooperation between AMSAT-NA and AMSAT-DL has all but stopped because the Americans do not want to inadvertently break the law that prohibits the exportation of what might be deemed as sensitive research and technology.

The sanctions for violating the regulations can run into millions of dollars, as Boeing found out when it was fined $32 million for its role as successor to the Hughes Corporation, which had (according to the U.S. government) illegally transferred technology to China concerning the January 1995 failed launch of the Long March 2E rocked that was carrying the Hughes-built Apstar 2 spacecraft.

From Wikipedia (see: http://en.wikipedia.org/wiki/International_Traffic_in_Arms_Regulations) is the following concerning the controversy:

> There is an open debate between the Department of State and the industries and academia regulated by ITAR concerning how harmful the regulatory restrictions are for U.S. businesses and higher education institutions. The Department of State insists that ITAR has limited effect and provides a security benefit to the nation that outweighs any impact that these sectors must bear. Every year, the Department of State can cite multiple arrests of ITAR violators by U.S. Immigration and Customs Enforcement agents. However, many companies and institutions within the affected areas argue that ITAR is stifling U.S. trade and science. Companies argue that ITAR is a significant trade barrier that acts as a substantial negative subsidy, weakening U.S. industries' ability to compete.

It is my wish that under the new administration a new, healthier look at ITAR may emerge that will positively deal with the concerns within our hobby.

My Final Thoughts

Throughout the history of our hobby, we amateur radio operators have been called upon to provide essential communications and technological skills on behalf of our country. In laying out my wish list for the new presidential administration, I firmly believe that should these wishes be granted, once again the hobby of amateur radio will grow in numbers and therefore be able to provide essential communications and technological skills for use on behalf of our country—as well as the rest of the world. Until next time . . .

73 de Joe, N6CL

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  - EJ-50U TNC unit
  - EDS-9 Front-control unit separation kit

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A special CYØ 2x1 call, rare 6-meter grid square FN93, separate DXCC status . . . together equal big pile-ups! Here VE3IKV tells how he and his partners Dick Hanson, K5AND, and Chris Patterson, W3CMP, tallied more than 4000 VHF QSOs in late June and early July 2008.

By Pete Csanky,* VE3IKV

After our great VFØX summer 2007 6-meter arctic DXpedition to Nunavut Territory (VYØ), Bill, W4TAA, and I were talking about where to go in the summer of 2008. Hopefully, it would be to a location where we could work some Europeans on 6 meters, since up at VFØX we were too close to the north geomagnetic pole and never heard any EU signals or encountered videos on 50 MHz. We received quite a few suggestions to go to CYØ, Sable Island, which counts as a separate DXCC entity and was last activated during the summer sporadic-*E* season by Mike, VE9AA, and company back in 1996.

After making a few phone calls and e-mail inquiries, I found out that the main factor in getting CYØ on the air is the charter aircraft expense—$10,000 to get only 1400 pounds of combined operator, equipment, antennas, and food from Halifax to Sable and back to Halifax. Because it was a DXpedition focused on 6-meter operation, we never got much response from the usual HF DXpedition sponsors, so it looked like we would have to split the air charter costs. Adding in the Sable bunkhouse accommodation fees of $150 each per night, we were looking at around $10K each for the trip. Ouch!

While Bill and I were mulling over the costs, Dick, K5AND, and Chris, W3CMP, expressed their interest in joining us, and with the combined team, turning it into a major 6-meter DXpedition for the summer 2008 sporadic-*E* season.

Planning and Logistics

Thus, in September 2007 we started the lengthy planning necessary to secure landing permits from the Canadian Coast Guard and the Sable Island Officer-in-Charge, Gerry Forbes. We also applied for and received the special callsigns CYØX and CYØRA for the DXpedition. Adrian, EA5/GØKOM, kindly offered to sponsor the design and hosting of a website for us (http://www.cy0x.com) so that we could keep the 6-meter DX gang informed of our plans and progress.

Photo 1. QSL card for the 2008 CYØX Sable Island DXpedition. (Photos courtesy of the author)

At this time Bill, W4TAA, reluctantly had to pull out of the CYØX DXpedition plans due to business commitments, leaving Dick, Chris, and me to finalize the details. By spring 2008, it was apparent that after weighing each and every item that we were planning to bring to Sable, we were going to be over the allowed weight limit for the flight to the island. Dick and Chris then decided to pre-order enough food to last the trip, taking their food weight off the total amount and allowing us to also pack Chris's 2-meter station. Next, the charter flights to and from Sable were booked, and travel arrangements were made to get all the gear rounded up and staged at Pete, VE3IKV's QTH near Toronto.

One of the first things that the Sable visitor information sheet talks about is the high probability of fog delaying any travel plans to and from Sable in the

**e-mail: <ve3ikv@cogeco.ca>*

Photo 2. We are stowing our gear onboard our plane, a twin-engine Britten-Norman Islander. It is one of the few aircraft that can land on a beach, as there is no airport on Sable Island.

summer months and that the delays can last for several days or even much longer.

The Journey

June 25th, our departure day, miraculously arrived sunny and warm, the perfect day for the 1 1/2-hour flight out into the Atlantic Ocean to Sable.

We arrived at the air charter hangar to get all of our gear weighed and stowed on board the plane, a twin-engine Britten-Norman Islander, one of the few aircraft that can land on a beach, as there is no airport on Sable. Of course, when we added up all the weight once again, using their scale in the hangar, we were 150 pounds over the limit, and we then had to make on-the-spot decisions as to which items had to stay behind, since there were no guarantees of getting them over to Sable on a second flight. Good fortune was with us once again. Due to the favourable flying weather, the air charter folks could get a second flight over to Sable that day, and we were able to piggyback our left-behind items onto the second flight.

Photo 3. View from the aircraft of the Sable Island coastline.

Debbie, our pilot, gave us the pre-flight safety briefing ("The lifejackets are primarily to assist in the recovery of the bodies!") and we soon left the mainland behind. The western tip of Sable showed up on schedule, and we landed smoothly on the beach near the weather station. Gerry Forbes, the OIC, was waiting for us with his 4×4, and we off-loaded all our gear onto the truck for the drive to the Sable guesthouse.

Robby, VY2SS, had a custom 8-element M2 6-meter Yagi on a 40-foot boom that he had used for his CY9SS 2005 St. Paul 6-meter DXpedition, and he generously offered it for our use at CYØX. We put together the 6-meter station first in case there was an opening, but by the time we got everything operational and the big 40-foot M^2 Yagi up on the mast, it was late and there was no sign of activity on the band. We had a satellite internet connection that allowed us to post to the ON4KST 6-meter web page, so we told everyone to look for us in the morning.

The Operation

June 26 started off with our first 6-meter QSO (W1JJ) at 1150 UTC and continued with a number of stateside contacts until our first mainland Europe contact with S59Z at 1738 UTC, followed by I, DL, G, 9H, EI, F, CT, 9A, OK, SP, SM, HI, OZ, HA, GW, VP9, PA, and EA, ending at 2000 UTC. The band then shifted to the Caribbean/South America with KP4, 9Y4, J3, PJ2, YV4, and FM contacts, until 2200 UTC when Europe popped in again briefly with OY3JE in the Faeroe Islands.

We were ready early on June 27, and Europe was already coming through on CW by 0900 UTC. Nick, 5B4FL, was worked at 0930 UTC for our first Asian 6-meter QSO. The EU opening lasted until 1025 UTC and then switched to North America until 1350 UTC, when LZ3RX in Bulgaria opened the band to Europe again with OM, GM, GD, UR, GI, and LA contacts until 1730 UTC. The band then switched back to North America again until 2030 UTC, when K7CW and VE7SL, our first two West Coast stations, went in the log via triple-hop sporadic-*E*. Europe and Africa came booming in on SSB until 2145 UTC, including our first OH contacts in Finland. Six meters stayed open to North

Photo 4. Robby Robertson, VY2SS, loaned us this custom 8-element M² 6-meter Yagi on a 40-foot boom which he had used for his CY9SS 2005 St. Paul 6-meter DXpedition.

America until 0200 UTC, for a total of 17 straight hours of operating and over 1200 stations in the log.

IT9RZR in Sicily led the parade of Europeans early (0927 UTC) on June 28th, and we picked up new DXCC entities, including EA6, MUØ, HB9, and LY. Six meters once again opened to Scandinavia, and then at 1400 UTC we added YU, Serbia, and E7, Bosnia. At 1600 UTC, 4X4DK and 4X1FQ in Israel, and SV2DCD and SV8CS in Greece, broke the EU pile-up, and then only 15 minutes later, the path shut down completely and flipped over to North America for the next four hours until 0030 UTC.

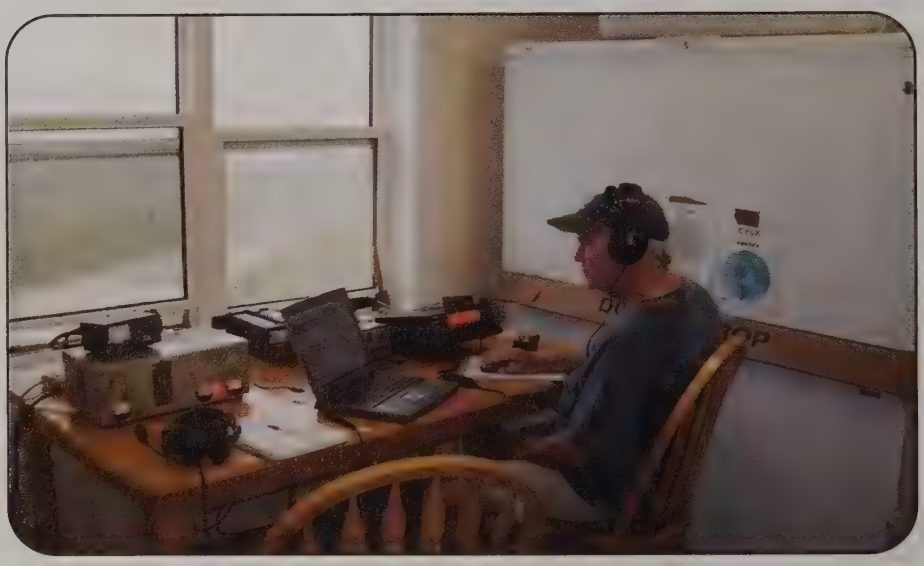

Photo 5. On June 26th CYØX is on the air on 6 meters!

The following day, Sunday the 29th, was ho-hum, but we did manage to get QSO number 2000 in the 6-meter log. Chris and Pete went on a hike to the freshwater ponds to look for wild horses and got some great photographs.

On Monday, June 30th, 6 meters opened up to Europe around our lunch time (1600 UTC) via a skewed path peaking toward West Africa, with UY5HF and UR7GG in the Ukraine worked at midnight their local time (2100 UTC). The skewed path stayed open to Europe for six hours, until 2200 UTC. Amazing!

The skewed path opening put another 250 Europeans in the 6-meter log, including LX1JX in Luxembourg for our 6-meter DXCC number 55, and the first ever CYØ to LX 6-meter QSO. However, we were still waiting for the anticipated "killer" 6-meter opening stateside.

Six meters was quiet all day on July 1st, but returned with another morning opening to Scandinavia and central Europe on July2nd, followed by North America until 1700 UTC.

July 3rd and 4th were both quiet on the band, with few stations getting into the CYØX log, but we did manage to work PJ6/K2KW on Saba, VP5/WB2REM, and HK3O for three new ones, bringing our 6-meter DXCC count to 58 entities.

Six opened to Europe again on Saturday morning, July 5th at 1300 UTC for a couple of hours, but the "biggie" to central and western North America failed to materialize. At the 11 AM local-time weather briefing from Gerry Forbes, we got the first hint that our scheduled departure date for Monday "doesn't look good." Dense fog was forecast for the next several days, until a weak cold front "might" come through and bring drier air "later in the week." Sensing our disappointment, Gerry assured us that we should be able to leave "by Labor Day, September 1st," which was not exactly the extended stay we were anticipating!

To make matters worse, Sunday July 6th arrived with rain as well as fog, and we only managed to work 13 stations on 6 meters all day. Dick and Chris stayed busy on the guest-house satellite phone re-scheduling their flights home to Texas and Pennsylvania, respectively, and trying to convince the XYLs that we really *were* trying to leave Sable. Without a single decent opening to them so far, all the USA Midwest and West Coast 6-meter

Photo 6. Some of the wild horses on Sable Island.

ops by now had given up all hope of working CYØX.

At that point, we decided to take down all the 6-meter and HF antennas and pack up all the stations, just in case a decent weather window opened on short notice and we could leave the island.

Pete had brought along Bill, W4TAA's 6M5X antenna as back-up, so he decided late Sunday to unpack it and go ahead and put it up on top of a 20-foot aluminum tower that had been left on the island. The rotators all had been packed, so we used a piece of nylon guy rope attached to the end of the boom to swing the beam.

Monday, July 7th, our original planned departure date, dawned with dense fog, just as Gerry had predicted. Six meters stayed dead all day until 5 PM local (2000 UTC), when just as we were getting ready to cook dinner, it opened to North America with an instant huge pile-up on our 50.108-MHz frequency. By now, everyone had heard via the internet that we were fogged in and they all were calling, hoping for one last chance to get into the CYØX 6-meter log. By the time the band folded at 0100 UTC, there were another 342 very happy W/VE stations in the log. The little 6M5X was working

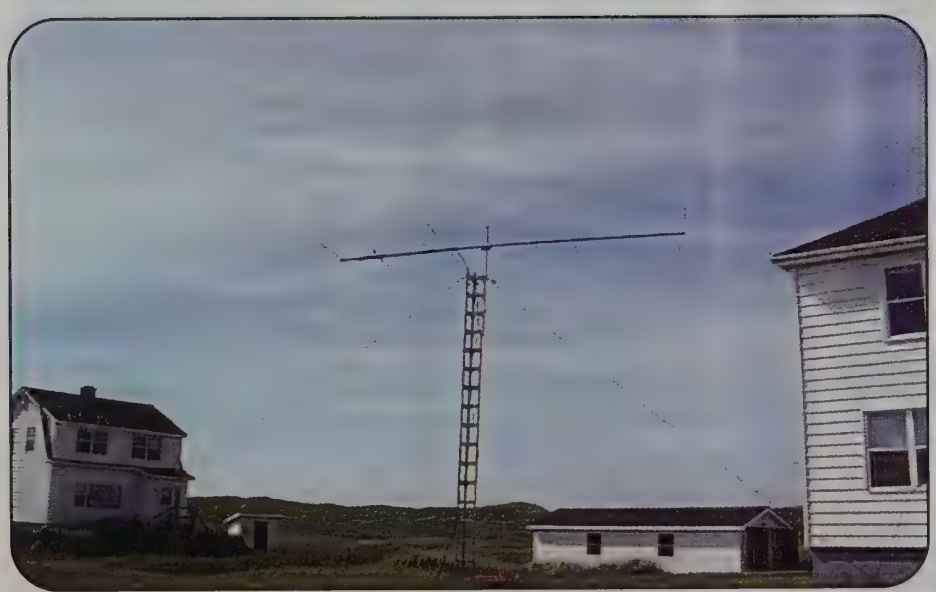

Photo 7. Our "temporary" 6M5X 6-meter Yagi which we used during our "extended" stay on the island.

Photo 8. Some of the more than 250,000 seals on the island.

great, in spite of being only 20 feet high.

Tuesday, July 8th, "The Biggie" finally arrived! The band opened up early in the morning at 1130 UTC to W8s and W9s. Then the Caribbean came in off the side, and we worked Ted, HI3TEJ, some YV4s, and Joe, CT1HZE, off the back of the beam. Then XE2WWW came blasting in S9-plus, and we also connected with VP2MRM on Montserrat. The band stayed open to stateside all day, and finally around 2100 UTC we put a number of anxious WØs in the log, with a very difficult sporadic-*E* path in the "donut hole" between hops. At 2200 UTC the West Coast finally came in on triple-hop when Barry, VE3CDX/W7, in Las Vegas broke the Midwest pile-up on CW!

For the next hour the band went wild. Chip, K7JA, in Los Angeles led the W6s calling in from all over California, and all U.S. call areas went into the log at the same time as VE1s, VE2s, VE3s, and VO1s—with CT1EAT, CT1ESV, and CT1DVV in Portugal calling in off the back of the antenna for good measure—while all the W6s and W7s were shouting "We *love* fog!"

After a QSO with KØEU in Denver, the band finally closed at 0130 UTC. It had been open for 14 hours straight!

Wednesday, July 9th, we awoke at 6 AM to the densest fog yet. With no wind, there would be no flight out that day. At 7:30 AM (06:30 Eastern), Pete turned on the Yaesu FT-650, not expecting to hear any signals after Tuesday's marathon session, and was amazed to hear the band full of loud W1, W2, W3, and W4 beacons below 50.075 MHz! For the next hour and a half, we worked around 30 very surprised early birds. They were extremely strong, S9 +30 dB, with no sign of any sporadic-*E* QSB. There was a huge tropo fog inversion down the Atlantic coastline extending from Sable Island all the way down to Ken, AC4TO, in Tallahassee, Florida! The morning tropo session then started to overlap with yet another sporadic-*E* opening to W4s, W8s, W9s, and even a long double-hop to W5UR in Albuquerque, New Mexico. The sporadic-*E* continued until 1730 UTC, with the expected afternoon break, and then picked up again at 2130 UTC with all call areas except W6 and W7 coming through non-stop until 11 PM local (0200 UTC), when we finally put QSO number 3668 in the 6-meter log!

On Thursday, July 10th, we awoke to still more fog! Oh well . . . there was

Photo 9. While the horses are wild, they were also friendly and curious. Here is one of them coming up to us in our Jeep.

Photo 10. The "Gator," our transportation between the guest house and the Jeep.

Photo 11. The welcome sight of Debbie piloting our plane in for a landing at "Sable International Airport."

always the guest-house satellite TV, and now the XYLs were more convinced than ever that we are in no hurry to leave the island. The band couldn't *possibly* be open again. However, when we turned on the 6-meter radio, we found that *it was*! There were more W1s, W2s, W3s, W4s, and W5s calling, and even KS7S in southern Arizona came through at 1400 UTC (7 AM his time). Jay, WXØB, "Mr. Stackmatch," called in from Array Solutions in Texas to say hi!

Like clockwork, the mid-afternoon break occurred again between 1600 UTC and 2200 UTC, so all three of us took another stroll and stretched our legs on the island.

At 2200 UTC Thursday evening, after dinner, the band re-opened again, and we had more W2s, 3s, 4s, 5s, 8s, and 9s calling, and even Bill, KØHA, came in on double-hop from Nebraska. Later that evening, at 0141 UTC, the band finally closed with AJ9C on CW for 6-meter QSO number 3941!

Friday, July 11th, the cold front came through with dry air and the day was sunny and warm, finally with no fog, but we were *still* stuck on Sable because our pilot Debbie was unavailable. Gerry gave us our daily WX briefing at 11 AM and said it "looks good" for the Saturday flight off the island.

The band was totally dead, and remained that way all day Friday. We left the 6-meter beacon on, but nothing came through either from Europe or North America, so we took one last tour of the island before our departure. We took down the 6M5X Friday evening and tallied up our "fogged-in" QSOs with just 100 watts and the "temporary" 5element antenna—1309!

Departure

Saturday, July 12th, the day dawned bright and sunny again and we packed all our stuff in the "Gator" that would transport it between the guest house and the Jeep.

We drove off to the beach landing strip with all of our gear in the Jeep and watched Gerry lay down the location of the "runway" in the sand and then put the wind sock up on a pole on the front bumper. Sable Island International Airport was ready for incoming air traffic, and we were ready to go home!

Final Totals

- 3941 QSOs on 6 meters, in 60 DXCC entities and 45 USA states
- 3750 QSOs on HF (20 and 40 meters), in 80 DXCC entities
- Only 7 QSOs on 2 meters via tropo, meteor scatter, and EME because of RFI from weather-station computers, water in the antenna balun, RFI to island equipment when running over 50 watts, etc.
- 2-meter stations worked: VE9AA, VE1KG, VE1HD, WZ1V, WA1T, K1WHS, and W5UN.

Photo 12. From our take-off we have a farewell view of Sable Island's coastline.

The WinCube Project

In this article we see how Manitoba (Canada) high school students have become involved in pico-satellite construction, amateur radio, and high-altitude balloons.

By Stefan Wagener,*[1] VE4NSA, Jeff Cieszecki,[1] VE4CZK, Barbara Bowen,[2] Wayne Ellis,[3] and Norm Lee[4]

The WinCube Project is a cooperative effort among Manitoba high schools, the Manitoba Satellite Interest group (MSIG), the Faculty of Engineering at the University of Manitoba, Maples Collegiate Space Exploration Academy, the Manitoba Aerospace Human Resources Coordinating Committee, and numerous aerospace industry partners.

Through a mentorship program, Manitoba high school students will be involved in the design, construction, and launch of a pico-satellite with technical support provided by aerospace faculty and engineering students. Basic system design and construction experience for the high school students is provided by the construction and launch of high-altitude balloon payloads. Students learn first-hand about space mission design, telecommunications, programming, electrical and mechanical engineering, and amateur radio through a summer camp program, ongoing workshops, and courses.

WinCube

The WinCube project (photo 1) is a multi-facetted approach of exposing high school students to amateur radio, aerospace, science, and technology. Its core areas involve a satellite project (CubeSat), an annual summer space camp, a high-altitude balloon project (B-Cube), and annual amateur radio classes combined with hands-on construction projects, as well as the operation of existing and future amateur radio satellites through a new satellite ground station.

The CubeSat Project

The CubeSat Project was initiated in the spring of 2006 by the Manitoba Satellite Interest Group (MSIG) Inc., and MindSet, the Manitoba Network for Science and Technology, to provide Manitoba High School students with the opportunity to be involved in the design, construction, and launching of a pico-satellite.

Initial funding for the project was obtained through NSERC (Natural Sciences and Engineering Research Council of Canada) and MindSet as a program of Manitoba Science, Technology, Energy, and Mines. The project is designed to challenge students in the fields of science and technology. The pico-satellite is based on the California Polytechnic State University (CalPoly) CubeSat Program design and specifications of a cube satellite with the dimensions of 10 × 10 × 10 cm and a maximum mass of 1 kg. These small, relatively inexpensive satellites are capable of real data gathering as demonstrated by their utilization by universities and space researchers as an economical method of research.

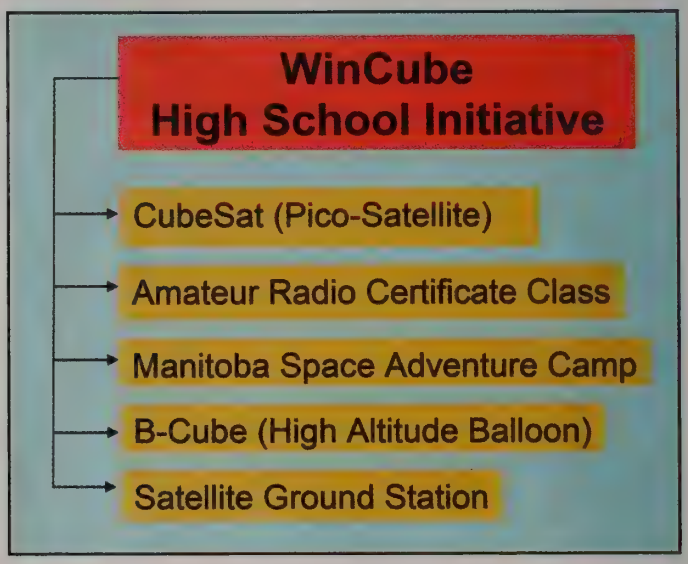

Photo1. WinCube project components.

To achieve this lofty goal of creating and launching a pico-satellite, a number of key factors needed to be put into place for the high school students:

- Mentorship through aerospace industry and university students
- Gaining experience in payload design and construction through high-altitude balloon work (B-Cube Project)
- Defined educational goals
- Amateur radio certification and ground station operation

For high school students to create a CubeSat, the Faculty of Engineering at the University of Manitoba with assistance by Bristol Aerospace provided initial design support for the satel-

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[1]Manitoba Satellite Interest Group (MSIG), Inc., WinCube Project Team
[2]Manitoba Aerospace, WinCube Project Team
[3]AppSpace Solutions, WinCube Project Team
[4]MindSet (Manitoba Network for Science and Technology), WinCube Project Team
(Originally published in the 2007 AMSAT Symposium Proceedings*)*

lite. This was necessary to meet the CalPoly specifications for a space-worthy satellite. A Preliminary Design Review (PDR) Report was created by a cohort of fourth year Engineering Students at the University of Manitoba during the 2006–2007 school year.[1] The PDR proposes the design of the satellite and includes:

- Structure
- Electrical Power
- Communication System
- Command and Data Handling
- Attitude Control
- On-board Science
- Integration and Testing

The "on-board science"[1] will be responsible for gathering scientific data that will be transmitted back to Earth for analysis. The high school students will contribute directly to the science component. When the CubeSat is in orbit, participating high school students will communicate with the satellite via amateur radio. Data gathered will be processed and published by the high school students.

High school students will also take an active role in the construction of the CubeSat. Starting in the fall of 2007, students will be mentored by University of Manitoba Engineering graduate students during the next phase of construction and testing of the satellite utilizing the new University of Manitoba space lab. To prepare the high school students for the satellite construction, they will gain experience in satellite design by constructing and testing a scientific payload for a high-altitude balloon launches. The high-altitude balloon work is referred to as B-Cube.

Manitoba Space Adventure Camp

It is necessary to increase students' basic knowledge of space studies and related concepts before they begin their work on a satellite. Students in the program range in grades from 10 through 12. Students must have the basic concepts and vocabulary necessary to understand space science. A "space camp" experience is provided to bridge students' knowledge of high school physics and the concepts and vocabulary they will encounter during their CubeSat experience. The Manitoba Space Adventure Camp, as it is called, has been held for two years at the Canadian Forces School of Aerospace Studies, 17 Wing, Canadian Forces Base Winnipeg. It is designed to make high school students more aware of science and technology as it relates to aerospace. The Manitoba Space Adventure Camp actually involves two separate camps: a first-year camp and an advanced camp for returning students who continue their participation in the CubeSat project. While most of the activities take place at the Canadian Forces School of Aerospace Studies, students also have the opportunity to build and launch model rockets, operate satellite navigation devices, participate in a research balloon launch, and work with amateur radio via satellites. Other activities include tours and lectures, geocaching, and various lab sessions (http://appspacesol.com/spacecampmain.html).

Photo 2. Manitoba Space Adventure Camp, 2007, successful ARISS contact with the ISS.

The key event of the 2007 Manitoba Space Adventure Camp was the successful "school" contact with the International Space Station (ISS), which took place on July 12, 2007 (photo 2). The maximum elevation of the ISS was 70 degrees and the contact lasted for over 9 minutes. Astronaut Clayton Anderson answered 18 questions on a variety of issues, and some of students who took part in the 2006–07 winter amateur radio class had their first ISS QSO as certificate holders (http://www.msig.ca/iss%20contact.html).

B-Cube (High-Altitude Balloon) Project

The CubeSat student design team from the University of Manitoba and MSIG identified a number of key engineering areas for the satellite. As stated earlier, the technical expertise required for a space-ready satellite is beyond the skill set for most high school students and science teachers, and since the first year of satellite design is primarily theoretical, real-life, hands-on project developed to provide a basic understanding of the intricacies of payload design and fabrication. High school students are given the challenge to create a payload for a high-altitude balloon. Some of the similarities between the B-Cube payload and the CubeSat are taken from the Preliminary Design Review (PDR) Report by the University of Manitoba's Satellite Team[1]:

- Payload Frame
  - * Structure
  - * Thermal Design
  - * Passive/Active Thermal Control Systems
- Electrical Power
  - * Power Budget
  - * Active/Standby Mode
- Communication
  - * Requirements
  - * Amateur Radio Use
- Antennas
- Command and Data Handling

The CubeSat once constructed will undergo a number of tests to evaluate its space readiness, including exposing the craft to a hard vacuum, extreme temperatures, and vibrations. For the B-Cube, testing will include physical impacts, cold temperatures, and systems tests. The

B-Cube tests can all be carried out at each high school by the students.

Payload Frame. The engineering points listed are those that only apply to the B-Cube design concept. For example, in designing the B-Cube payload frame, students must take into consideration temperature drops and how the electronics within the payload react as the balloon reaches a potential altitude of 30 km and external temperature drops as low as –60° C.

Areas for consideration in the B-Cube structure by high school students include the material for the walls (aluminum, foam core, foam insulation)[2], type of adhesives for the structure walls (silicon adhesive, hot glue, loop-form attachtment, aluminum tape) and the dimensions of the structure. Students may need to refine payload dimensions to effectively contain all equipment necessary for the balloon launch, yet limit the mass of the structure to the overall 1-kg payload mass. The design of the B-Cube structure must also allow for the venting of the internal volume to adjust to external atmospheric pressure changes, internal heat loss/gain, and possible moisture damage from clouds.[2]

Electrical Power. High school students will also learn about electrical power budgets in the design of their B-Cubes. The B-Cube payloads are expected to operate for 2.5 hours of flight and run an audio beacon upon landing for an extended period of time to aid with ground retrieval. The choice of batteries will also require investigation and testing for suitability.

Communication. Communication plays a key role in the tracking and data gathering of both the satellite and the B-Cube payload. The high school students are required to obtain their amateur radio certificates, since balloon-to-ground communication will utilize amateur radio frequencies similar (VHF, UHF) to those planned for the satellite. The certification will allow the students to communicate directly with the future CubeSat while in orbit via a ground station located in Winnipeg. First-hand application of amateur radio operation is done by having the B-Cube payloads tracked by a GPS radio beacon that is transmitting on 144.390 MHz based on APRS (Automatic Position Reporting System). The students will use amateur radio transceivers and computer software to track and retrieve the balloon payloads.

Command and Data Handling. Command and Data Handling of the B-Cube payloads will be done with Basic Stamp chips. The Basic Stamp is reliable and uses PBasic programming. Students will create programs that meet the needs of their mission designs. This includes the timed operation of a balloon flight termination device, as well as the control of on-board cameras. Future projects will involve real live ATV transmissions.

Photo 3. B-Cube-1 ready for launch.

B-Cube payloads are tested for impact survival. Students construct a number of prototypes of payloads that contain a mass that places the test container to a total of 1 kg. Payloads are first tested by dropping them (e.g., off the school roof) to evaluate the structure's impact survivability. Payloads are then dropped off with various dimensions of parachutes, comparing the time of descent. The third drop test involves a drop from an elevated altitude with the use of a kite or a tethered balloon. The payload is released via a cut-down mechanism (termination device), and the payload floats to the ground with the use of a parachute, again recording the time of decent and the altitude from which it was dropped. In all of these tests, students are determining the relative strength of the payload structures and the best dimension of the parachute design for optimal results versus mass constraints.

A key component for any payload is to be able to operate in extreme temperatures. Both the WinCube and B-Cube must have measures taken to allow the operation of the electrical system at all times during flight. In the case of the B-Cube, extreme drops in temperature are an issue, as low as –60° C. The B-Cube payload can utilize either an active or passive thermal control system, to be determined by the students. One possible test for temperature is to place an operational payload in a cooler filled with dry ice [2] or a freezer. In either case, the payloads

should be running during the tests, with internal and external temperatures of the payload continuously monitored.

In order to help high schools in Manitoba and beyond to engage in a high-altitude balloon project (independent of the satellite project), funding was obtained from the Canadian Space Agency (CAS) to design and construct a ready-to-be-assembled B-Cube kit. Currently, preliminary prototypes of the kits are being developed and tested. These kits will be available in the beginning of 2008. This "plug and play" approach is very important for many science teachers in order to quickly incorporate such a project into the ongoing science curriculum of their schools and guarantee a certain level of success.

One of the key elements of high-altitude balloons using APRS is the possibility to closely work with local amateur radio operators for the purpose of testing payloads, radios, balloon tracking, and recovery. These "balloon chase" events are very popular and significantly enhance the working relationships of local hams with high school students and teachers (photo 3).

Educational Goals

Educational goals for the WinCube project were developed from the Common Framework of Science Learning Outcomes (Pan-Canadian Framework) written by the Council of Ministers of Education, Canada (CMEC).[3] General Learning Outcomes (GLOs) from the Pan-Canadian that apply directly to the WinCube Project include skills, communication, and teamwork.

Pan-Canadian GLO for Skills includes planning investigations to record and analyze data using a variety of techniques. For the B-Cube payload design or the science component of the satellite, students will develop the function of these payloads while attempting to address a scientific issue.

The GLO for Communication and Teamwork involves the effective communication with others in regard to issues and ideas, and comes up with a strategy that has a consensus to move forward. For the B-Cube component, students will work as a team to design a payload within a high school. The satellite will require students from participating high schools to discuss and agree upon what the science component will accomplish once in orbit.

Specific Learning Outcomes (SLOs) from the Pan-Canadian Framework found in the WinCube Project include Initiating and Planning; Performing and Recording; Analyzing and Interpreting.

Initial BCube payload designs will be very basic—simply to launch and retrieve a payload. Subsequent payload designs will have more specific scientific goals. The SLO of Initiating and Planning involves the investigation of practical problems and issues and the creation of scientific investigations to gather data. The SLO of Performing and Recording will have students carry out experiments while controlling variables, effectively collecting and compiling data. With data collected, students will analyze evidence, provide conclusions, and display information using a variety of formats as part of the SLO Analyzing and Interpreting.

Further educational opportunities include ongoing certification in amateur radio and potentially high-powered rocketry. During the 2006–2007 school year, participating high school students took part in classes for amateur radio certification. Amateur radio is a key component of the WinCube project which allows students to track their B-Cube payloads and communicate with amateur radio satellites, including the WinCube CubeSat. The amateur radio course will again be offered during the 2007–2008 school year.

A planned additional course that was to be offered to participating students in the fall of 2007 was a junior certification in high-powered rocketry. The rocketry course would provide students with a better understanding of the physics of launching payloads into space.

Conclusion

The WinCube is now in its second year and has integrated a number of different projects under one umbrella. The combination of these projects makes the WinCube idea novel and exciting for all participating partners. In addition, such a multi-faceted approach has been very appealing for external funding groups and agencies and will be used to further enhance our ability to deliver these programs to high schools in Manitoba and beyond.

Acknowledgments

Our special thanks and appreciation go to the Winnipeg Amateur Radio Club (WARC), ARISS (Amateur Radio on the International Space Station), the 17 Wing (Winnipeg). We gratefully acknowledge the financial support provided by NSERC, CAS, and MindSet and thank the following individuals for their great involvement and support: Alan Thoren, VE4YZ; Steve McFarlane, VE3TBD; Dieter Schliemann, KX4Y; Greg Linton, VA4GL; Albert Sousa, VA4AS; Geoff Bawden, VE4BAW; Fred Venema, VE4FV; Gerry Baker VE4GTB; Rory Winters, VE4RJW; and Melanie Rennie.

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The Basement Laboratory Group: A Pioneering VHF Club

Part 3 – A Year to Remember

In Part 1 of this series on the Basement Laboratory Group (Summer 2008 issue) WA2VVA featured Carl Scheideler, W2AZL, and his well-known converter. In Part 2 (Fall 2008 issue) WA2VVA featured his father, Walt Morrison, W2CXY. In this part there are excerpts from a special Christmas tape recording that his father prepared for Ralph "Tommy" Thomas, W2UK/KH6UK, who at the time was residing in Hawaii.

By Mark Morrison,* WA2VVA

This, the third article on the Basement Laboratory Group, has two sections. The first section gives a brief history on aurora, VHF scatter communications and in particular items of interest from the year 1956. The second section is selections from a transcript of a Christmas tape WA2VVA's father put together for Tommy Thomas, W2UK/KH6UK, when he was living in Hawaii. It includes a number of VHF pioneers telling their own VHF stories in 1956. Most of the guys on the tape are no longer with us. Even so, their words to Tommy provide both relevance and history for us today.

The History

For the members of the Basement Lab Group the year 1956 was a year of anticipation, not just for the upcoming sunspot/aurora cycle, and the opportunity to participate in the International Geophysical Year (IGY), but also for the chance to communicate with Ralph "Tommy" Thomas, W2UK. Just one year earlier, RCA had relocated Tommy from New Brunswick, New Jersey to the Hawaiian Island of Oahu. It was there that Tommy would join the ranks of an elite group of radio men—those who once served as Engineers-in-Charge of the Marconi Transpacific facility.

In this remote location, Tommy was removed from anything approaching the VHF bands he left back east. In letters written to Walt Morrison, W2CXY, Tommy expressed interest in getting back on the VHF bands, even though little activity existed there at the time. In order to encourage Tommy, Walt produced an audio tape as a Christmas greeting from Tommy's friends back home.

Walt sent a form letter to over two-dozen VHF pioneers, asking each to prepare a 10-minute audio tape of what they had accomplished in 1956 and what they hoped to accomplish in 1957. The final master, which Walt spliced together from all the tapes returned to him, is a reflection of the early days of VHF radio not just from the perspective of those living it, but *when* they were actually living it!

Presented on the following pages is a brief history of those days, followed by transcripts taken directly from Walt's Christmas tape.

Background History of the VHF Ham Bands

Aurora: Although astronomers have been counting sunspots for thousands of years, the potential for sunspots to interrupt everyday life on Earth was not appreciated until the widespread use of telegraphy came into being. In 1856 *The New York Times* reported how a huge aurora caused interference with telegraph circuits all across the nation and described how the aurora "took possession" of telegraph offices, causing "all sorts of fantastical and unreadable messages" to be received. Numerous other references to aurora-induced Earth currents finding their way into the telegraph wires, and disrupting railroad operations, can be found in the literature.

When the discovery of radio-wave propagation came on the scene years later, it was also discovered that the aurora affected the radio-wave propagation as well. The need to understand this phenomenon became one of commercial interest as well, because telegraph networks and railroads depended on reliable communications. By the late 1800s the link between sunspot numbers and the aurora was generally recognized, as was the 11-year sunspot cycle.This meant that radio operators, telegraph operators, and railroad operators all could expect service disruptions on a regular cycle.

Although aurora initially was blamed for interfering with communications, VHF enthusiasts would later exploit this natural phenomenon as a means of extending the VHF horizon. Indeed, the solar cycle that peaked in 1948 led to the amateur

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discovery of 50-MHz transequatorial (TE) propagation in 1947, a form of propagation that allows VHF signals to bridge the oceans between the Northern and Southern Hemispheres. This discovery was big news, because VHF signals were thought to be limited to line-of-sight propagation and not able to travel over the horizon.

The Demise of Channel One and the Rise of Long-Range VHF Propagation: With the advent of high-power television stations, more evidence suggested that VHF signals could indeed propagate over the horizon. The unexpected co-channel interference that resulted with fixed, mobile, and amateur allocations all in the same band prompted the FCC to eliminate shared services in 1949. Ever wonder what happened to TV channel 1? By 1950, Cornell researchers Booker and Gordon had developed the theory of VHF scattering.

The quest for reliable long-distance communications led to commercial and military interest in VHF scattering. The most ambitious project was that of the Collins Radio Company. In 1950, Collins began experimented with powerful transmitters on 49.8 MHz to see if VHF scattering might prove reliable for over-the-horizon communications. The earliest experiments used transmitters on the order of 30 kW for a path between Iowa and Sterling, Virginia. As a result of these experiments, a new form of VHF propagation was discovered, that of VHF Ionospheric Scattering. With sufficient power, and sensitive enough receivers, communications was reliable over 90 percent of the time at distances over 1000 miles!

It is interesting to note that over-the-horizon VHF propagation was actually predicted by Marconi as early as 1932, as the result of his own experiments with microwaves. However, the necessary high-power transmitters and ultra-sensitive receivers would not be available until the development of radar decades later. Until that time, Marconi stuck to the low frequencies and used up to 300 kW to set the standard for reliable communications in his globe-girdling network of stations, including the one managed much later by Tommy at Kahuku.

One important difference between the Marconi and Collins circuits was that geomagnetic disturbances actually enhanced the ionospheric signal while interfering with the Marconi signal. Had it not been for the development of satellite technology just a few years later, Marconi's network may well have been replaced by a comprehensive scatter system. Indeed, Marconi was one of the big players in early scatter technology.

The relative immunity of scatter communications to geomagnetic disturbances made it ideal for use in polar regions, where the aurora was a common occurrence. To this end, ionospheric as well as tropospheric scatter systems were a critical element of the Defense Early Warning System, or DEW line.

It is interesting to note that many of the 28-foot Kennedy "tropo dishes" that were used in DEW-line operations later played an important role in amateur moonbounce experiments. In the early days, both Sam Harris, W1FZJ, and Tommy Thomas, W2UK, used such dishes, and even today moonbounce authorities such as Al Katz, K2UYH, still put them to good use.

Although the "Collins Colossus" was a loosely kept secret, with magazines such as *QST* and *CQ* expressly prohibited from mentioning it, many amateurs using 6-meter gear knew that something was happening because of the curious signal that was always there.

By 1956, the publishing ban was lifted, and Ed Tilton, W1HDQ, suggested in the January 1956 issue of *QST* that amateurs should do more to exploit this propagation mode using

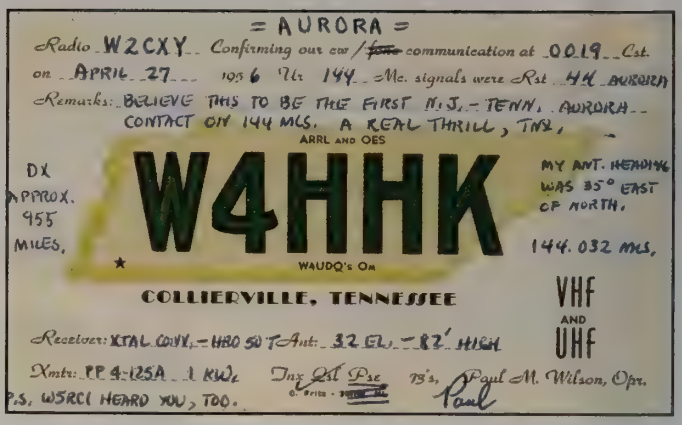


Figure 1. The QSL card of W4HHK documenting the April 27th contact with Basement Laboratory Group member Walt Morrison, W2CXY.

their own 6-meter gear. He mentioned how his own experiments with Paul Wilson, W4HHK, using only modest power, had already generated some good results.

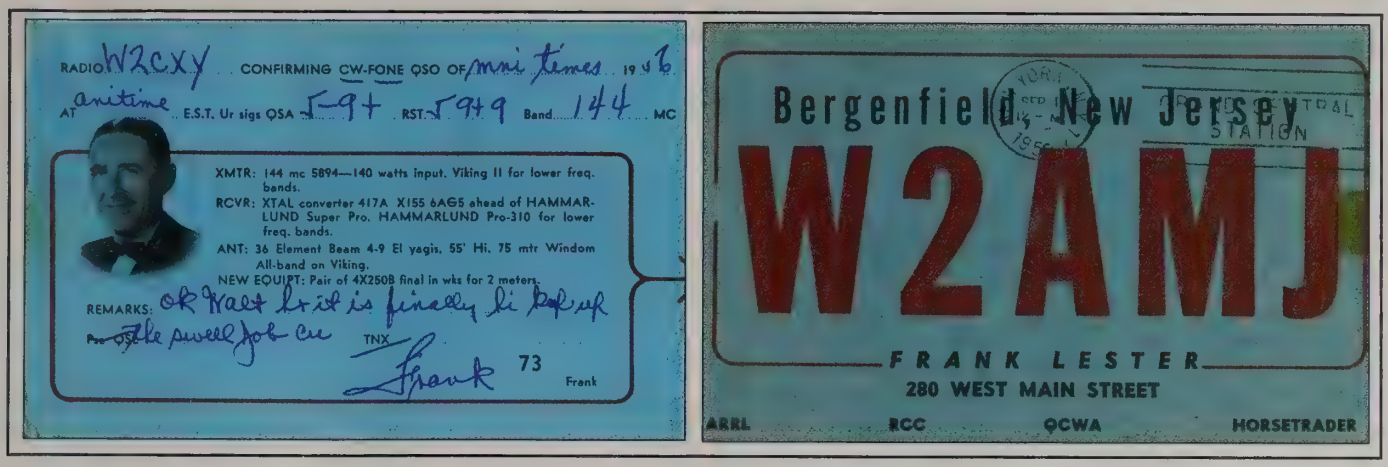
In March 1956, Mark Moynahan, W2ALJ, published a comprehensive article on the subject in *QST* magazine. Mark explained how the ionospheric scatter signal is always there, and "barely perceptible against the background of cosmic noise."

It was in 1956 that the number of amateurs operating on VHF frequencies was ever growing and with the peak of the next sunspot cycle expected in 1957, many were looking to improve their "states worked" and "best DX" totals. Weak-signal operators already established with high-power meteor-scatter and aurora stations were in a good position to investigate VHF ionospheric scatter, especially those with 6-meter gear. Reports of England coming through on 6 meters only added to the excitement!

Ed Tilton was particularly concerned that amateurs weren't making the most of their assigned VHF frequencies and continued his encouragement of readers to give 6-meter ionospheric scatter a try. In February 1956, Ed reported that in addition to Paul Wilson, W4HHK, Walt Bain, then W2WFB and now W4LTU, would "welcome skeds with stations at suitable distances from Ithaca." Tilton described Walt's station as having a 1-kW final and a stacked Yagi array for 50 MHz.

When scientists invited amateurs to participate in the IGY, Tilton once again encouraged amateurs to get in the action, taking advantage of the increasing number of sunspots and the opportunity for amateur radio to contribute to our scientific understanding. After all, if not for radio amateurs pushing the limit in the late 1940s, TE might not have been discovered. Furthermore, with so many more VHF stations on the air in 1956, who knew what discoveries might lie ahead.

In the spring of 1956 strong aurora activity swept the nation, with April and May bringing optimum conditions for VHF communications. Tilton's "The World Above 50 Mc." column in the July 1956 issue of *QST* quotes Paul Wilson, W4HHK, as saying the April 26–27 session was "the best aurora in my v.h.f. experience." It was reported that Paul worked an impressive string of 2-meter stations all the way from the Midwest (W8SVI, W8PT, and W8DX) to the East Coast (W2CXY, W2PAU, W2AMJ, W2AZL, W4RUE). Figure 1 shows the QSL card of



Figures 2 & 3. Paul's contact with Frank Lester, W2AMJ, of Bergenfield, New Jersey was called by QST *"one of the longest 2-meter aurora hauls ever reported." Shown are two parts of the distinctive foldout QSL card of W2AMJ.*

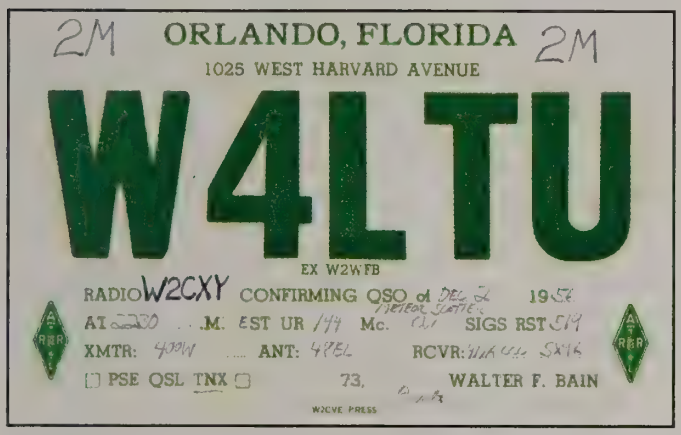


Figure 4. When Walt Bain (ex-W2WFB), W4LTU, moved to Florida, he became a sought-after DX station, as few high-power meteor-scatter stations existed there at the time. This is Walt's QSL card from that era.

W4HHK documenting the April 27th contact with BLG member Walt Morrison, W2CXY. According to Paul, this is believed to be the first Tennessee to New Jersey aurora contact, one good for 955 miles!

However, as impressive as that contact with W2CXY was, Paul's contact with Frank Lester, W2AMJ, of Bergenfield, New Jersey was even better, as Frank lived several miles farther north of Walt. *QST* called this "one of the longest 2-meter aurora hauls ever reported." Figures 2 and 3 show the distinctive foldout QSL card of W2AMJ.

The same aurora also helped Walt Bain, then W2WFB, of Ithaca, New York, log 91 two-meter stations in six call areas and 17 states during the April 26th opening alone! Later that year, when Walt relocated to Orlando, Florida, he picked up his original W4 call, W4LTU. Those familiar with meteor-scatter communications will recognize W4LTU as the author of two classic *QST* articles on the subject, both of which are current even now. When Walt moved to Florida, he became a sought-after DX station, as few high-power meteor-scatter stations existed there at the time. Figure 4 shows Walt's QSL card from that era. Walt Bain exhibited that true amateur spirit as he unselfishly helped other stations across the United States and Canada pick up Florida as their best DX.

The Christmas Tapes

The year 1956 proved to be an exciting year, first with the announcement of a new VHF propagation mode, ionospheric scatter, then with some of the best aurora sessions in modern history, followed by an invitation from the scientific community for amateur radio operators to participate in the IGY. It was also the year in which many an amateur got started in 2-meter meteor-scatter operations, following the path blazed by W2UK and W4HHK. As interesting as it is to read about those days, it's quite another to listen to those who lived it tell their stories. Thanks to Walt, W2CXY, an important chapter in amateur radio history has been preserved. What follows are transcripts taken from Walt's 1956 Christmas tape to KH6UK giving an eyewitness account of 1956. Sit back and "listen" as many of our VHF pioneers tell the story of 1956 in their own words.

Walt Morrison, W2CXY, Chatham, New Jersey: Hello there, this Walt again, W2CXY, as if you didn't know. It's late December of 1956. The holiday season is upon us and Christmas is almost here. Christmas is also the reason for this tape. Many words can be used to describe what follows, but fortunately the tape speaks for itself.

Walt Bain, W4LTU (ex-W2WFB), Orlando, Florida: Hi Tommy, this is Walt Bain. I used to be W2WFB up in Ithaca, NY. I worked you quite a few times there, mostly on CW. I'm down in Orlando, Florida here right now and the new call is W4 "Love, Tear, Uncle." I got my old W4 call back [see figure 4] and you may have heard we've been doing some meteor work from down here that turned out real well. We've made five contacts so far. That's just about the only contacts to be made down here.

I didn't get set up in time for the *Perseids* shower but during the *Orionids* I worked W9WOK, W3GKP, and W2ORI there. WOK and ORI there it was on the long over dense burst. On WOK the burst lasted for about 100 seconds and John's signal was running S9 on the meter there. If I had the presence of mind to flip on the modulator we could have made it the first phone contact on meteor I guess. Let's see, it was GKP that was the other over dense.

Incidentally, Smitty was having transmitter trouble at the time. He had a measured power of 15 watts I believe into the antenna at the time I worked him. I could just barely read him here but he was getting good signals from me. And I worked John up there, ORI, to give him his 27th state I believe. That was on short under dense pings with lots of repeats. And then it was during the *Taurids* I worked 2NLY there I guess for the first Jersey Florida. Then during the *Andromedids*, just recently, I worked 9KLR. Just getting ready for start *Geminids* skeds here and want to pick up a few more, hi!

I wonder how things are out there, Tommy. I wonder if you hear from much of the old gang there. I wonder if you hear from a mutual friend of ours here, 2OPQ up there, old Fran. I understand you're trying to get set on 2 meters there and work across to the mainland there. I sure hope you can do it there. I guess that's kind of a long haul for meteor scatter. I guess you're aiming toward the lunar angle. I want to get in on that a little bit too. I'm going to run some tests with 2NLY here after the first of the year. [More on those tests in a future article.] I got a 48 element here now, four long Yagis spaced 2 wavelengths and I'm running 400 watts here now. When I left Ithaca I had to give back my borrowed plate transformer but hope to get a KW final on here pretty soon and then work some real DX, hi.

Activity is pretty poor down here. There's the usual Gonset crew that congregates up on their prescribed frequency up on the high end and works with their vertical whips and so forth and that's almost the extent of it, although there are a few stations scattered around at 50 to 100 watt class I guess, but aside from the meteor work the only out of state contacts I've made are into Alabama and into Cuba. CL2VY is on down there with a good setup and I've even worked Georgia, hi!

Well I guess that's just about it from here Tommy. Thanks an awful lot for the QSO. I never thought I'd have to work you this way but since you went way off into the Pacific there why I certainly wouldn't want to have to go down on 20 meters or anywhere there, hi! So Merry Christmas there Tommy. If you get back in the states maybe we'll be working you direct sometime. In fact, maybe we can work you out in KH6 there if we get working on this lunar reflection stuff. 73s for now there Tommy, from Walt, W4LTU, ex-W2WFB.

Lawrence Lewis, W2ALR, Lockport, New York (see figure 5): KH6UK this is W2ALR at Lockport, NY calling. Hello Tommy. Very pleasant to be talking with you again on tape. Congratulations on winning the 1955 ARRL award on the meteor burst with Paul. Very, very good work. I hope you keep it up on moonbounce.

Working for Sylvania Electric Products in the Military systems Division has involved some travel and consequently I didn't get all the projects done this summer that I'd hoped to. A 64-element beam for normal use every day and a 128-element beam for moonbounce. Though I did collect the necessary parts to put together the 128-element antenna, I think we'll be able to do that throughout the winter and some of it next spring.

In the shack we've obtained a wire recorder and managed to record some of the better auroras and some of the meteor scatter skeds with 2ORI and 4LTU, Walt, ex-W2WFB, who's now in Orlando, Florida. I expect John will tell you all about that. All we can say is that we listened.

Am storing in the shack now a 75A2. One of the local lads has gone away to college and consequently we've been able to use a 75A2 for about the last 6 months. And it's been very, very pleasant. It's a terrific receiver compared to what we've been

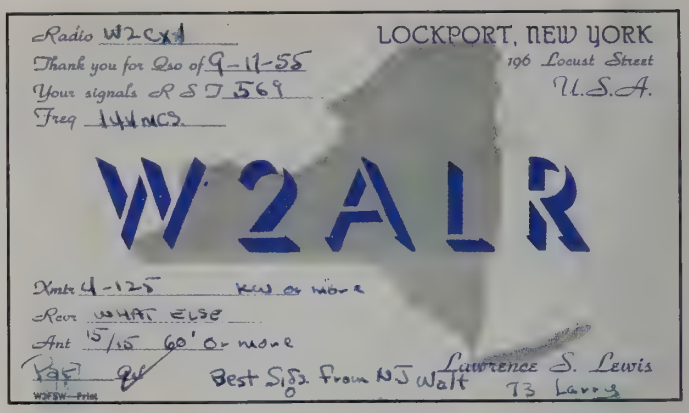


Figure 5. The QSL of Larry, W2ALR, sent to Walt, W2CXY, for a contact on 144 mc in 1955.

using and makes working DX on 2 meters an awful lot easier. I'm afraid if he ever takes it away from me I'm afraid I'm going to have to break down and get something of that order.

Some of our other activities: I've built a 6-meter transmitter, 100 watts to a 9903. Using a crystal controlled cascade converter for receiving in the 75A2. Modulator 6146's and a 4 element beam on another 30 foot telephone pole. ... Today is Sunday the second of December. Just this morning I missed an opening into England on 6 meters. I don't believe anybody worked, but W2WII of Geneseo was heard in England by G5 baker dog, or something like that. We've got 20 states now Tommy, on 2 meters this is. I was heard in North Dakota here a little while ago. I heard him and he heard me. We both called each other and I think his call was WØSYJ, but didn't connect. Heard Florida, by way of 2ORI's meteor scatter skeds and heard Iowa a couple of nights ago on aurora.

No tropospheric openings around here at all this summer Tommy. I've worked as far as Illinois and down through that area. I heard Paul on once this year on a tropospheric opening but by far and large the majority of openings we've had this year have been on aurora and a majority of DX was worked on meteors I think. The aurora, I don't know, maybe it's a false impression but lately here we've had some aurora almost every week. I think maybe this shows a trend upward with the sunspot cycle to lots more aurora.

Dick Cotton, W8DX, Detroit, Michigan (see figure 6): Hi Tommy, this is Dick Cotton, W8DX, of Detroit, Michigan. Sure miss the signal of W2UK in there when the aurora is on. There's

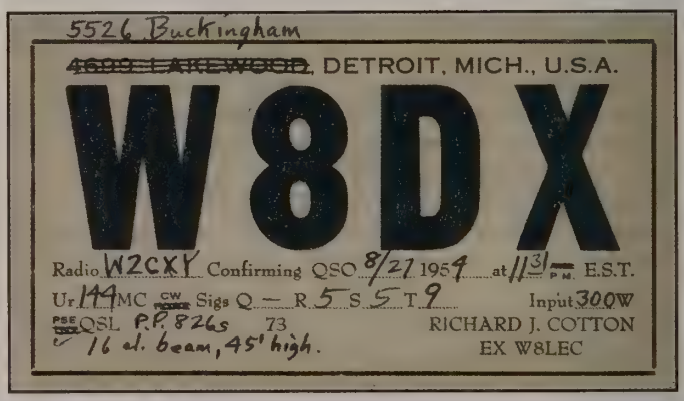


Figure 6. The QSL card of Dick, W8DX, sent to Walt in 1954.

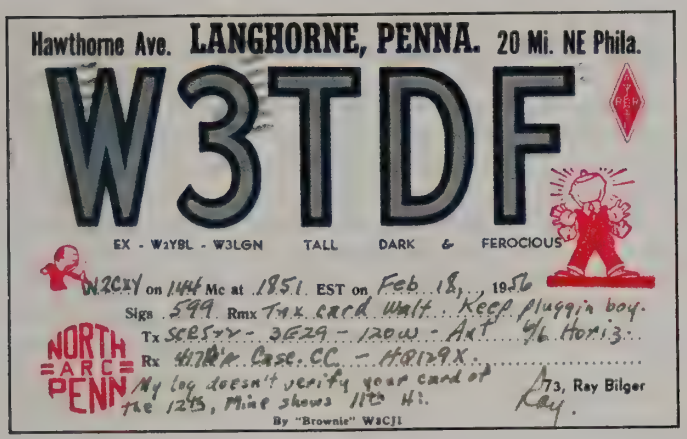


Figure 7. Ray, W3TDF, sent this card to Walt for a 144-mc contact in 1956.

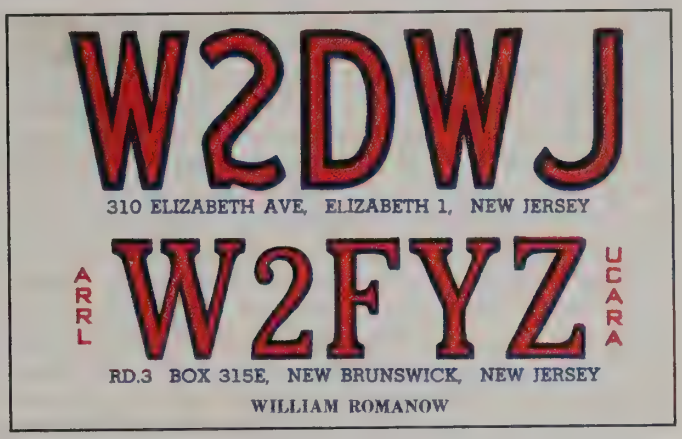


Figure 8. Bill, W2DWJ, of Elizabeth, New Jersey contributed to the Christmas tapes of 1956.

been a lot of aurora this year. I worked over 150 stations in 23 states by aurora alone in the past year, including 30 W1s in all six New England states. New Hampshire and Maine were new states of course and I've also added Nebraska in the westerly direction. Heard North Dakota and South Dakota also on aurora but no luck on contacts. Direct openings are rather scarce this past season and no new states were heard or worked that way.

I'm still running 1 kW to a pair of VT-127As and narrow band FM on phone. I have a 45 element beam up for 144 which was pictured in April 1956 *CQ*. Also have 350W on 220Mc and a 30 element beam. And 50W on 432 with a 45 element beam which is a scaled down version of the 2 meter job. I'm still working on my ham TV here but not on the air as yet. The camera is working fine but the modulator and the sync troubles are plaguing me as well as lack of time. Want to wish you a Merry Christmas and I'd sure like to hear your signals out here in Detroit. And I hope we can hear W2UK on again sometime. This is W8DX of Detroit.

Ray Bilger, W3TDF, Langhorne, Pennsylvania (see figure 7): Glad to get this chance to talk to you and Helyne. … We're running meteor scatter skeds with W4LTU all this week December 9th to 14th or something like that. Well, when are we going to get together, you and I, and start making schedules on 6 meters? The way that 6 has been open it "oughtn't" to be too long, boy! Say the word when you're ready.

This guy Walt, 2CXY, boy he is a rough character! I've been trying to take him in the contests, Tommy, as far as section multipliers are concerned, but I can't seem to top that boy. I don't know. You've got a pretty good protégé there holding down the fort until you get back.

By the way, still running the same 100 watts here.... Same old beam, 6 over 6, no changes… The old 417A converter is really doing a bang up job, A-1, 100 percent!

Bill Romanow, W2DWJ, Elizabeth, New Jersey (see figure 8): We're still running a hundred watts here. We've picked up the sockets and we're thinking of the 4×150s per *QST* there, only we'll double up. We've got all our antennas on one boom here and we built up a 50-element beam similar to Walt's there. Two-twenty activity is pretty good around this area but 420 there's just a few but they're coming up. We picked up two states this year I think in the early part of the year on aurora. But that was it. When you saw in *QST* where AMJ worked 4HHK I picked up Wisconsin. I missed HHK so we still have to get him.

Frank Lester, W2AMJ, Bergenfield, New Jersey (see figures 2 and 3): Calling KH6UK, KH6UK, KH6UK, this is W2AMJ. W2 April May June, the spring station at Bergenfield, northern New Jersey via W2CXYs tape recorder wishing you and yours a very, very Merry Christmas and Happy New Year.

Nothing too much to report. We've been able to get out of the back yard a little bit with the hundred watts. Have added trigonal reflectors to the old 28-element beam which you undoubtedly saw in the October issue of *QST* and have plans for completing a new California Kilowatt, and I mean California, using a pair of CX300s, the new ceramic tetrodes being talked about by Eimac recently. But at the rate I'm going

I imagine it will be sometime in the reasonably early part of 1957 before we'll be able to fire it up.

I actually ordered a tape recorder to make up a little recording for you but it's still on the way and Walt on this nice Sunday morning of December 16th is making the tape for me via 2 meters and off the back of the beam! I just got through talking to Matt, W1EY(?) who is starting to play with sideband and was running a big total of about 9 watts input to a Class A linear up there in Fairfield, Connecticut and coming down here to Bergenfield in nice shape. I also want to extend for everybody else up here that isn't on the tape wishes to you for a Merry Christmas, happy and prosperous 1957, including Tony, VE3DIR. I don't know whether Walt is going to get a tape from Tony or not. If he does, I imagine it will have to be by other means than this since the band hasn't been good enough for Walt to cut a tape from Tony directly. I don't know whether you know it or not, but he's going to take the "fatal step" in I believe April of next year and the picture of his "better half to be" was in a recent issue of *CQ*.

I can't think of anything else much to tell you except that naturally we're all hoping that one of these days KH6UK will come "bopping through" on 2 meters and by that time maybe I'll have the new final running and we'll work two-way the long way around! I guess that's about it. It looks like I've "gassed on" here for 3 minutes wandering along. So once again, here's hoping that you're enjoying the Hawaiian atmosphere out there and not drinking too many "poi eyes" I think they're called. So without further ado Tommy, I want to once again thank Walt for putting this down on the tape and we'll close once again by wishing you a very happy, prosperous, etc., healthful of course, 1957. W2AMJ through the courtesy of W2CXY who is cutting this tape via 2 meters is now off and clear and turning it back to you Walt.

Carl Scheideler, W2AZL, Plainfield, New Jersey: Well, OK Tommy, we'll be seeing you and we'll be working you on 2 one of these days, Tom, we hope. And don't sell the old meteor scatter stuff short with your friend there in California [W6NLZ]. You ought to try that with him one of these days on a good shower. The possibility is there, boy. So anyway, we'll sign with you now and see you next Thursday if the Lord is willing; 88s to Helyne and 73s to you and I hope "Santy Claus" is good to you.

Telephone Conversation

What follows is a transcript of a phone conversation among the following hams in December of 1956: Paul Wilson, W4HHK, Collierville, Tennessee (see figure 1); Tony Sheppard, VE3DIR, Toronto, Canada (see figure 9); and Walt Morrison, W2CXY, Chatham, New Jersey

Paul: You were up out whooping it up last night, were you? It looked like they were doing the same on NBC last night. Yes, we had several "boo boos." Some queue leader going through the projector and things like that on the station break. And we closed out with Steve Allen's Tonight Show and having a good time… "dB" [an affectionate name for Paul's wife] baked a bunch of goodies and we nibbled on goodies all evening, nothing exciting. Won't be able to climb if I eat too much! … One thing I've been concerned about, the phasing line that goes from each 16 element bay down to the matching transformer is this 400-ohm TV lin e…so I suspect I might improve things by replacing those phasing lines with new ones and trying to overhaul the whole feedline …When I can get around to it, before I can do any replacing, I've got to rig some sort of platform or mast to enable me to get up above the top of the tower about a few feet to be able to reach to the point where I have to solder, because without a little preliminary scaffold work I can't begin to reach it. It's not a matter of just going up there and replacing it but I think when I do that I'll probably hear a little better and maybe transmit a little better.

Tony: Well, all you've got to do is get "dB" to climb to the top and stand on your shoulders!

Paul: I don't know if she'd go for that or not!

Tony: I've been kidding her about getting to the top of one of those hundred-foot sticks and she sounds kind of leery about the whole thing!

Walt: By the way, who does climb those-hundred foot sticks?

Paul: Well, I do because I have to, and my partner GYS. And they're really steady. The two towers are nine feet apart, half wave on 6, and each guy station is cross braced one to the other with a framework of 1 inch steel angle. They're like a ladder, you know. And the two towers make a big ladder. It's quite rigid and steady. And, well, I haven't written you since, but just the other day we finished putting up all the booms, so all 24 elements are up there now. But the phasing lines are not connected to anything. I've got to mount the matching transformer and a couple of junction boxes so to speak and then we're in business.

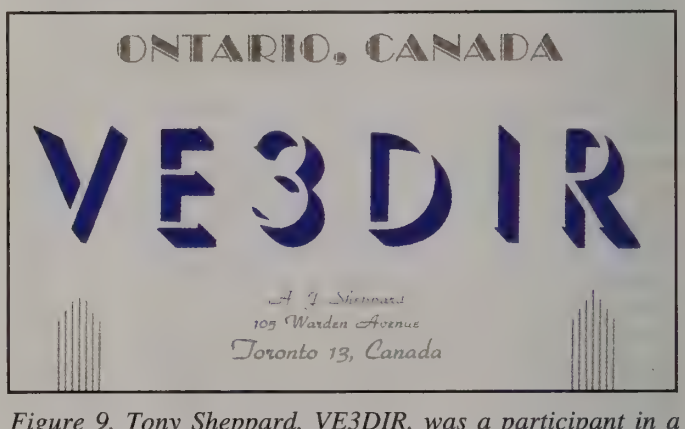


Figure 9. Tony Sheppard, VE3DIR, was a participant in a December 1956 phone conversation among W4HHK, W2CXY, and VE3DIR.

Figure 10. According Walt, W2CXY, in 1956 aurora sessions were very interesting and numbered 48 in his particular part of the country, with the best sessions observed probably around April or May, when Rex Turner, W5RCI was hearing Walt and other East Coast W2s.

Tony: Never mind all this hogwash about 6, how about the Long John on the top for 2!

Paul: Well, that'll come later! Because it should be a near perfect location, of course there's the power line coming in, but except for that only an occasional tractor. There's nothing within a mile. In your direction there's just a gentle slope downhill, Oh for at least a mile.

Tony: See, that's what I mean. You've got to get rid of all that 6 meter stuff! Now, if you put up a Long John for each element that you've got on 6, well that might be something!

Paul: What I hope is to have some sort of reliable scatter circuit with the boys up east so I don't have to depend on the telephone. Judging on what the 4 element did here … it might do pretty good, but time will tell.

Tony: Yeah, well, come on Walt, needle him a bit about 2 for goodness sakes! We've got to work 4RFI for Tennessee these days.

Walt: Yeah, I thought he was going work a lot of VHF bands but he's a converted 6 meter man, I can see that!

Paul: Merry Christmas Tommy and Helyne, this is Paul, your old "Tennessee turtle" speaking… "dB" is sawing little logs right now.

Tony: And the same from me too!

Tape Ending

What follows is a transcript of how Walt ended the tape in December of 1956:

W2CXY: Back to Chatham, New Jersey now. Much has been said, and much has still to be done. At this end, in recapping the work of 1956, tropospheric openings of any great magnitude on 2 meters were practically non-existent. Aurora sessions were very interesting and numbered 48 in this particular part of the country, with the best sessions observed I think somewhere's around April or May, when Rex Turner, W5RCI (see figure 10) was hearing this station and other East Coast W2s.

Progress by the gang included several new kW amplifiers, larger antennas, and more 417 converters resulting in a lot of crowding at the low end of the band, receiver overloading, and cross modulation being quite a common occurrence, especially between stations within a 15 or 20 mile range radius. Nothing new on exclusive CW segment for the band, something to look forward to working on in 1957. Many of the gang picked up some new states via the buzz [aurora] sessions. Some worked some W8s for the first time in Ohio or Michigan. Some worked W9s in Illinois and Wisconsin. No WØs were heard at this end, in this particular area at any rate, neither were any W5s except perhaps by Brownie, W2PAU, who was … hearing W5RCI during that April or May buzz session.

The program for 1957 includes a more efficient final amplifier, about which you heard a little bit tonight, a monster, circularly polarized antenna for moon-bounce work and in connection with this latter item. Are there any takers?

(Editor's Note: When we were in the final stages of editing this article at the end of December, word reached us that Rex Turner, W5RCI, who is one of the pioneers mentioned in this article, was expected to live for only a few days. In response to this sad news, special arrangements were made to e-mail a copy of this article to him in hopes that it would provide him with some comfort during the remaining days of his life.)

Riding the Terminator From 6 Meters Down to 160 Meters

A major amateur radio operation from above the Alaskan Artic Circle took place for the first time in many years this past July during the Alaska Convention. Adding to the special aspect of the event was gaining permission to use the call W1AW/KL7. Amateur radio activities took place from HF to microwave frequencies. Here is the story.

By Gordon West,* WB6NOA, and Bill Balzarini,† KL7BB

In our ham radio hobby, it is rare when you actually get to both see and operate inside the natural medium that supports our RF signals and takes them to faraway places. Such is the case in the far north of Earth's Arctic Circle. Alaska's Arctic Circle just happens to be one of the places on Earth to which people can actually drive. Because of the summertime conditions, the Alaskan Arctic Circle has a full day of the sun's effect on radio propagation. Sunrise, sunset, full daylight, and twilight are the active times in which the 66° 33' N latitude location offers operators of radio equipment a full-day possibility of having their signals reach somewhere far away, DX locations. Depending on the ham bands used, the RF signals can take multiple hops to reach exotic distant locations.

The magic becomes evident when astronomy programs are put to the task of showing (from an outer-space perspective high above any Earth location) the difference between day and night. It is along that magical line where the direction of the RF path really jumps out and gives a very clear picture as to where the paths are pointing. It is best to make 24 one-hour incremental prints of each day's activity to help with the visualization during the middle of the night, when one is very tired from logging 6- to 10-plus straight hours of contacts.

Also, in that part of the far north, one does not want to spend very much time outside alone, adjusting the direction of a beam antenna, as one could become "dinner" for some foraging bear. It is a fact of life in that area of which one must be very cautious.

Dalton Highway Arctic Circle road sign. (Photos courtesy of the authors)

Just as with other types of DXpeditions, the signals may not be very strong at the start. It helps considerably that just one station finally receives that all-important first contact and creates a big fuss that alerts all of the masses to follow. Many contacts can follow that first effort, and once everyone has figured it out, you are on the fast track to running QSOs just as fast and furious as you can hear and log them!

I wrote down all of the contacts using pen and paper with a glance at the clock for time. The contact rate was slow enough to use to the closest minute for the log on phone contacts. The CW guys were all electronic in the logging and operational parts of the process. It was very impressive to see the fully automated logging and exchanges with that many stations calling from all over the world.

Once we were really "rocking and rolling," the hourly heading print-outs became the best tool of the operation. A quick glance at the log to see if another hour had gone by—and a fast peek into the sunrise-sunset one-hour pages—confirmed that once again it was time to go outside and redo the beam heading. Before going outside, there was the obligatory quick look to see if anything big and black was moving about the camp, lest we had a false sense of security of no bears in the camp and perhaps turning the beam would not be successful.

It was quite scary on our last night in camp, when one of the operators, Jim Adkison, WL7NJ, went outside for some

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Bill Balzarini, KL7BB, Calex Gonzalez, KL2BT, and Richard Tweet, KL2AZ, inside the weather port at the 2008 Alaska Convention.

air and spotted a big, black, 4-foot high "blob" jumping into the brush from behind his truck, only 150 feet from the operating positions. After all, however, it is their territory and we were strangers and intruders. It took Jim about two minutes to calm down and check out the operation, and then settle back into the contact mode with Asia and the Far East.

The "terminator," for those of us in the lower 48, is ten minutes of DX sunrise and sunset excitement nearly halfway around the world. However, for the recent W1AW/KL7 July-August two-week special-event operation as part of the Alaska 2008 Convention, riding the terminator on Alaska's Arctic Circle was a daily 20-plus hour blast in the Land of the Midnight Sun.

From the definition in Chapter 20.15 of the *ARRL Handbook,* the gray line consists of paths that can be considered a special form of long-path propagation that takes into account ionospheric configuration, along the twilight region between day and night. The gray-line DX propagation window supports the best of daytime and nighttime long-range contacts as one operator watches the sunset while the other operator is beginning to wake up to sunrise. Many times chordal "waveguide" propagation also takes place.

Inside the Alaskan Arctic Circle, the terminator between night and day allowed the ten W1AW/KL7 operators to literally "ride DX" throughout the many hours of spectacular sunsets and sunrises, from 6 meters on down to 160 meters.

"Back in the late '70s, I knew there was some exciting high-frequency nearly continuous propagation in June, July, and August during my electronic radio tech days with the Columbia Wards fisheries in Bristol Bay," comments Bill Balzarini, KL7BB, who, long before the event, accurately predicted the possibility of fabulous DX for the Arctic Circle team.

"From 2 MHz to 18 MHz, that band of frequencies was our only HF radio link between cannaries and our fishing fleets using a traditional long-wire antenna. After 9 PM local Bristol Bay Alaska time, I would switch the long wire antenna over to my HF radio and begin to hear late-evening foreign stations coming in on many 20- and 15-meter frequencies—nearly non-stop—for hours on end. Because we were just past a minimum of solar activity, the customary 20-meter band condition of being dead-after-dark was an anomaly of great signal strength in the high latitudes throughout Alaska," adds Balzarini.

Anchorage Amateur Radio Club, KL7AA's tower and generator at the W1AW/KL7 operation during the 2008 Alaska Convention.

Balzarini reports that these fabulous all-night band conditions were well known by famous DXer Chip Margelli, K7JA, operating at Rush Drake, W7RM's QTH from Foul Weather Bluff in the middle of Washington State's Puget Sound. "From the Bluff, the mega-station operators enjoyed great DX along with Coca Cola and chocolate chip cookies all night!" reports KL7BB, and confirmed by Chip, K7JA. KL7BB concludes, "May through August is the best time in KL7-land to enjoy sunset to sunrise DX."

Thirty years later, Balzarini suggested the DX possibilities at the Arctic Circle as one great way to celebrate the 2008 ARRL Alaska State Convention. He proposed this mini-DXpedition special event station to the W1AW/KL7 planning committee, which included: Richard Tweet, KL2AZ, Alaska Convention co-chair; Scott Honaker, N7SS/KL7; Roger Gollub, WBØCMZ/KL7; Calex Gonzales, KL2BT; BruceMcCormick, KL7BM; Mike O'Keefe, KL7MD; John Orella, KL7LL; along with several others.

Heather Hasper, KL7SP, the other Alaska 2008 Convention co-chair, agreed that it was an interesting idea. However, she recalled that the only road to the Arctic Circle, Old Pipeline Haul Road, followed the Alaska pipeline and was limited to only those with proper security clearance. The good news is that the formerly restricted road, now called the Dalton Highway, which runs from Fairbanks to the Arctic Circle and beyond, is now open to public access for over 500 miles of raw wilderness all the way up to the Arctic Circle.

"Just be sure to slow down to prevent windshield damage from flying pebbles," commented the husband and wife team of Janet, KL7MF, and Chip Margelli, K7JA, when I traveled with them to Coldfoot, Alaska, 60 miles beyond the Arctic Circle. Rental cars are told to stay off the road, but there was

Scott Honaker, N7SS, in front of the W1AW/KL7 operating tent during the Alaska Convention.

no limitation to hams with personal trucks, trailers and towers, and hundreds of pounds of operating equipment for the two-week W1AW/ KL7 run, concurrent with the Anchorage, Alaska 2008 Convention.

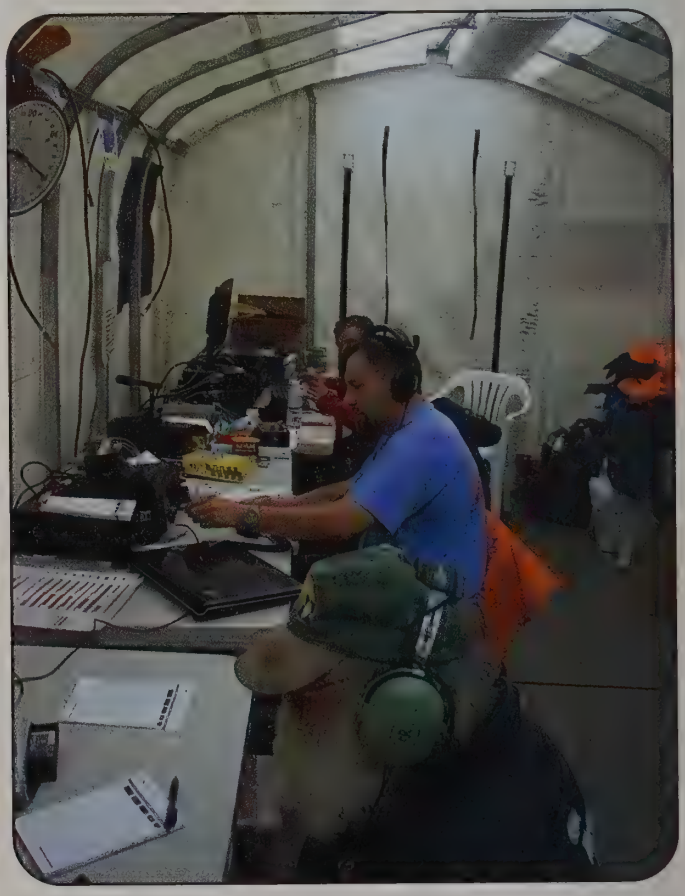
ARRL Executive Vice President Dave Sumner, K1ZZ, was presented the idea of a W1AW/KL7 special-event station. With input from ARRL Northwest Division Director Jim Fenstermaker, K9JF, and a nod from ARRL President, Joel Harrison, W5ZN, the Arctic Circle Convention expedition was approved.

"At the Arctic Circle in August, twilight at sunset and twilight at sunrise would last for hours on end for extraordinary gray-line terminator DX contacts. We weere actually skirting the *back side* of the gray-line terminator, being within the constant twilight side of the terminator, never seeing total darkness that would otherwise negate the gray-line DX path," explains Bill Balzarini, KL7BB. He adds, "Our summertime tilt of the Earth, this far north at the Alaskan Arctic Circle during August, gave us nearly eight hours of twilight DX.

A Stepp-IR Yagi allowed the operators to sort out the DX—one direction Europe, and 180 degrees out VK-ZL and Asia. Even though there was the constant auroral oval (unseen because there was no darkness), stateside contacts were easy by pointing the beam southeast.

Even though the first day they operated "barefoot," once their station got noticed and posted to the internet, the pile-ups continued nearly 24/7. Around 0600 UTC, Europe became a wall of white noise with thousands of stations

Richard Tweet, KL2AZ, and Scott Honaker, N7SS, at the HSMM microwave dish during the convention.



Front to rear: Mark Kelliher, KL7TQ; Calex Gonzalez, KL2BT; and Roger Gollub, WBØCMZ, at the W1AW/KL7 station.

calling. "Asia would start around 1000 hours UTC, with stations to the southwest peaking as they entered and exited their local brief terminator," adds Balzarini.

An interesting point that the many W1AW/KL7 team members made was keeping track of the DX potential stations' local time. There was not much DX if the distant stations were snuggled in their sacks during their 3 AM local sleep time.

On one weekend day, the Alaska operation coincided with IOTA, and one foreign ham didn't quite put the KL7 prefix into perspective and demanded to know what island the operation was on. "Look on most maps, and off the California coast to the southwest and you will find our KL7 Island plugged in, because they couldn't get us on the map," was the comment made by the W1AW/KL7 operator. Now that I think about it, I, too, have seen the Alaska "island" listed off southwestern California!

"Unlike the customary Arctic 'flutter,' our gray-line DX stations would remain strong for as long as the terminator was over the distant station. It was quite selective, and with the Stepp-IR vertical, with 24 radials, we could hear stations to the east and west come into view as the gray-line terminator would pass over their stations. Furthermore, the closer to the equator the station was located, the more brief the contact," adds Balzarini.

ICOM America supplied most of the HF equipment, as well as 2-meter D-STAR radios. All bands were on the air, from 6 meters on down, as well as the VHF and UHF bands. Jim Fenstermaker, K9JF, and Dave Sumner, K1ZZ, with the ARRL, were among the first contacts on CW. It was a 14-day operation, with Anchorage clubs operating for the first week and Fairbanks clubs taking over for the second week special convention event. A tradeoff of equipment was

Roger Gollub, WBØCMZ/KL7 Silent Key

By Bill Balzarini, KL7BB

This story is about Dr. Roger E. Gollub, M.D., and how in many ways he was the real-life version of the popular *Northern Exposure* television doctor Joel Fleishman played by Rob Morrow. Dr. Roger Gollub was tragically killed on November 19, 2008 in a dog-sled and snowmobile accident in Kotzebue, Alaska . Dr. Gollub, a pediatrician, was out in Kotzebue performing his medical work for the [Alaskan] Indian Health Service.

Dr. Gollub was taking a ride-of-a-lifetime dog-sled trip and had a chance to ride on the runners for the full experience of mushing in the still of the dark winter Arctic Circle night with the crisp cool Bearing Sea coast air rushing past his face for that extra nip and bite that says you're deep inside of Alaska's winter wonderland.

Dr. Gollub was born in New York and went to medical school in St. Louis. While there, he also studied and received his WBØCMZ license.

It is through Roger's passion for ham radio that I had the wonderful experience of watching him talk all over the world this past July from Alaska's Arctic Circle special-event ham radio station. With the callsign of W1AW/KL7, Roger had many thousands of foreign radio operators from all over the world calling and trying to work him through the deep pile-ups that sounded like the loud roar of Seahawks fans cheering at the stadium during a home game.

Roger was very interested in how to get more youngsters into the hobby of ham radio, and he was very becoming heavily involved with the activities of the Anchorage Amateur Radio Club, KL7AA. The excitement he had that fired his imagination at the Arctic Circle operating event is evident in his own words for the Sweepstakes ham radio operating contest for November 15–16, 2008. He expressed that the working knowledge and momentary notoriety of the 66° 33' N. event gave him the confidence to expand into having two ham radio stations active and on the air for the November contest right there in Anchorage.

His specialty was to use his gentle, delicate hands to run the Morse code keyer paddles to put out the callsigns and language of "original digital" continuous-wave CW to the anxious foreign ham operators who were lucky enough to be copied in the sea of ionospheric chaos. With all of his years of training at the key of his many radio stations, he was able sort out the most complex patterns. Another one for the logbook surly made many happy people around the world this past July.

Roger also had a zest for fishing each year. The year 2008 found him and his wife down on the Kenai for July Salmon. While he was on the Alaskan Arctic Circle, he was eating one the last of of a dozen jars of the 2007 catch that he and his wife had put up. He figured that it was time to get ready for the 2008 catch and the 2007 batch had to go. What better way to enjoy the last of the fish than to take it with him to the Arctic Circle. He gave me a chance to try many of the remaining different samples of he and his wife's special varieties of seasoned smoked salmon, all put up in those tiny little jars. Yummy is the only word that come to mind for the Alaskan delicacy.

accomplished halfway between Anchorage and Fairbanks, which was a classic example of distant amateur radio organizations coming together to make the Arctic Circle project happen. Just imagine that the ham bands were open to exotic DX locations for 20-plus hours per day, and this took place during the time when the sunspot activity was *zero*!

The VHF side of this operation was not as prolific as the low bands. The 6-meter operation was on the air each morning from about 5 AM to 7 AM in an attempt to work stations on the west coast of the USA. The ICOM 756PROIII was used with the KW amp into the Multiband Stepp-IR beam aimed SE in order to be into the gray-line terminator as it approached and traversed the west coast of the Americas. No contacts were made during that time. The operation was mostly inside the gray-line terminator zone, so the operators noticed almost no aurora effect which you would normally hear if you are outside looking in. They were not inside the auroral zone, but rather just outside the edge and the band conditions were very calm and settled. Because this late-July 2008 window was during the time when the Sun was producing zero sunspots, there was no pulsing Sun energy thumping the Earth's *E*- and *F*-layers. That is a good thing, however, mostly for hot HF band conditions.

The operators described the 6-meter band as being just as normal as if you were in a great "out in the country" home location with great equipment and no man-made noise—no cracks, pops, snaps, or other buzzing. "It was surprisingly smooth, like warm butter spread over a fresh-baked slice of hot bread just popped out of the oven," adds Balzarini. Unfortunately, except for a few syllables coming over the calling frequency of 50.125 MHz, the 6-meter effort was a total washout.

On the other hand, the 2-meter operations were done on several levels over the various times when the supporting groups and operators could be on site, that being Anchorage and Fairbanks. The main talk-in frequency was on 146.52 MHz simplex with a simple ground-plane antenna. The 145.100-MHz D-STAR Net was local and ran on simplex. History was made history as W1AW/KL7 was the first station to run D-STAR from the Alaskan Arctic Circle.

One of the hams from the Fairbanks area made contact with W1AW/KL7 from his float plane as he was flying supplies farther up the road to a remote bush fishing camp on a lake. On his way back he flew a giant circle overhead of the entire Arctic Circle setup, all the while talking with everyone on the ground on 146.52 FM simplex. Many of our operators posed for a group picture all holding ICOM D-STAR 2-meter radios.

Various hams operating D-STAR on the Arctic Circle, posed in front of the W1AW/KL7 operating tent.

The operators from Fairbanks also supplied their satellite equipment and packet gear. Contacts were attempted through the Big Balloon launch on July 29 from Fairbanks. That operation allowed the many other hams in the state a chance to work all over on VHF. See: <http://www.bear.437am.com/> for all of the energy and equipment that was put into this project, and the BEAR 2 balloon sidebar.

As for our microwave operation, we were on the Hughes.net system which was supplying us with our high-speed internet connection for data and pictures on the Alaskan Arctic Circle. Thanks go to many people who stepped up to the task, including Will Johnson, KL7KT; Jerry Curry, KL7EDK; Richard Tweet,

Front to rear: Roger Gollub, WBØCMZ; Calex Gonzalez, KL2BT; Bruce McCormick, KL7BM; and Jim Adkson, WL7NJ, operating W1AW/KL7 during the Alaska Convention, as well as a visitor from Holland whose back was to the camera.

Jim Adkison, WL7NJ, operating from the W1AW/KL7 station.

KL2AZ; and Scott Honaker, N7SS. Their collective efforts and talents made the equipment work and helped with setting and aligning with the other equipment that was just a few degrees up over the horizon. The entire team then had a fantastic way to communicating to the outside world as to how well the operation was progressing from setup to when we were on the air. Even regular tourists to the Arctic Circle camping area were treated to the router's WiFi 802.11 wireless signal. It was quite an enhancement to being out among the Alaskan bears.

BEAR 2 Balloon Launch

The Balloon Experiment And Research (BEAR) Program at the University of Alaska Fairbanks BEAR 2 Balloon was launched at 10:11 AM on July 29, 2008, as scheduled in conjunction with special-event station W1AW/KL7. One of the payloads on the balloon contained the packet (digipeater) system which allowed amateur radio operators from across the state to communicate with each other.

Unfortunately, the APRS beacon signal was lost about 30 minutes into the flight. Along with its loss was the ability to track the balloon's flight path. While the APRS signal was erratic and unreliable, the digipeater worked exceptionally well, resulting in plenty of packet traffic among local hams and the special-event station manned by Bob Kreiser, WL7GK, as well as statewide ham-to-ham contacts.

Through monitoring of packet traffic—as well as Jerry Curry, KL7EDK, sending test messages during the tail end of the flight—it was determined that the digi was usable for the entire duration of the flight. Based on these observations, it was also determined that the flight lasted approximately 3 hours and 40 minutes.

The digipeater packet system performed exceptionally well and was a big hit for all who used it. Packet contacts on the digi included Fairbanks, W1AW/KL7, Chicken, Tok, Anchorage, Kenai Peninsula, Nilkiski, Delta Junction, McGrath, and others.

Although the packet system remained functional for over 3 1/2 hours while in flight, there was no way to receive APRS position reports. Therefore, the organizers presumed that the balloon would be permanently lost.

On Sunday, September 28, big-game hunter Jaret Owens was guiding a hunting party (Ron Rockstad) in the remote area of the West Fork of the Little Delta River (Healy D1 quadrangle) when he spotted something blue and yellow on top of a nearby peak. Being curious, he hiked up to the location and noted the BEAR 2 parachute and payload capsules. Fortunately, all the capsules had ownership and phone numbers written on the outside, so Jaret called Jerry Curry, KL7EDK, and later called Dan Wietchy, KL1JP, on his satellite phone informing them about his find. After returning to Fairbanks several days later, Jaret met with Jerry in order to return the balloon remnants. Obviously, the BEAR launch team has been very excited about the recovery of BEAR 2.

This sidebar is a summary of two reports on the BEAR 2 balloon that appear on the BEAR website: <http://www.bear.437am.com/bear2index.htm>.

A Nostalgic 6-Meter Radiotelephone Station

Do you remember the good old days of AM modulation? If you do, then you will appreciate the fact that there are others who do, too, and are doing something about their nostalgia. Here K8VBL describes what one group in western Michigan is doing and how to build a station in order to join them the next time the band is open in that direction.

By Thomas Turner,* K8VBL

Radio amateurs are fortunate to have been allocated the 6-meter band, 50–54 MHz, because "Magic Band" signals in this part of the radio spectrum are propagated by every known mode. In fact, the cause of sporadic-*E*, one of the most interesting modes of propagation, remains to be discovered. In this period of low sunspot activity, the beginning of Cycle 24, *F2* propagation is rare. Sporadic-*E* is seasonal, centered around the equinoxes (early summer and late December).

To maintain interest in the "Magic Band" during periods of minimal DX propagation and promote experimentation, the West Michigan Six Meter Net was formed. The net meets Tuesday evenings at 9 PM local time on 50.3 MHz SSB. Net control stations in Kalamazoo conduct the net as a round-table, with over 20 stations checking in. At around 9:30 PM the net shifts to 50.4 MHz AM. Many of the AM stations check in using a 1950s-vintage Heathkit "Sixer" transceiver, also known as the "Benton Harbor Lunch Box." A "WAS" certificate (Worked All Sixers!) is issued to those who use a "Sixer" to contact six other "Sixers."

Apple Hill Farm, 8530 N. Branch Rd., Watervliet, MI 49098

How About a Homebrew 6-meter AM Transmitter?

Using a loaner "Sixer" with about 2 watts output into my 3-element Yagi (*CQ VHF*, Winter 2006 issue), the West Michigan Six Meter Net proved to be a lot of fun and a good way to meet some interesting people. Then I thought, why not build a 6-meter AM rig with a little more power? A look in my junk box revealed all the necessary parts, including a half-bushel of 6L6 tubes from my dear, bygone days of the '50s repairing juke-box and electric-organ amplifiers. These tubes, dubbed the "poor man's 807 or 6146" were introduced in the spring of 1936 by RCA (*QST*, May and June 1936) as the first of the beam power tubes. *Radio* magazine for April 1937 carried an article "The Bi-Push Exciter" by W. W. (Woody) Smith, W6BCX, Editor. Using two 6L6 tubes in a push-push doubler connection, the 80- through 10-meter exciter soon became very popular. A bi-push is very efficient because it gives a pulse of power every half-cycle to a plate tank circuit tuned to the second harmonic of the grid (input) circuit. Excellent rejection of other harmonics is provided also. The newer 6L6GC tubes have about half as much input and output capacitance as the older type, and function well at 50 MHz. Design parameters selected for the transmitter were: simple oscillator and power amplifier using common

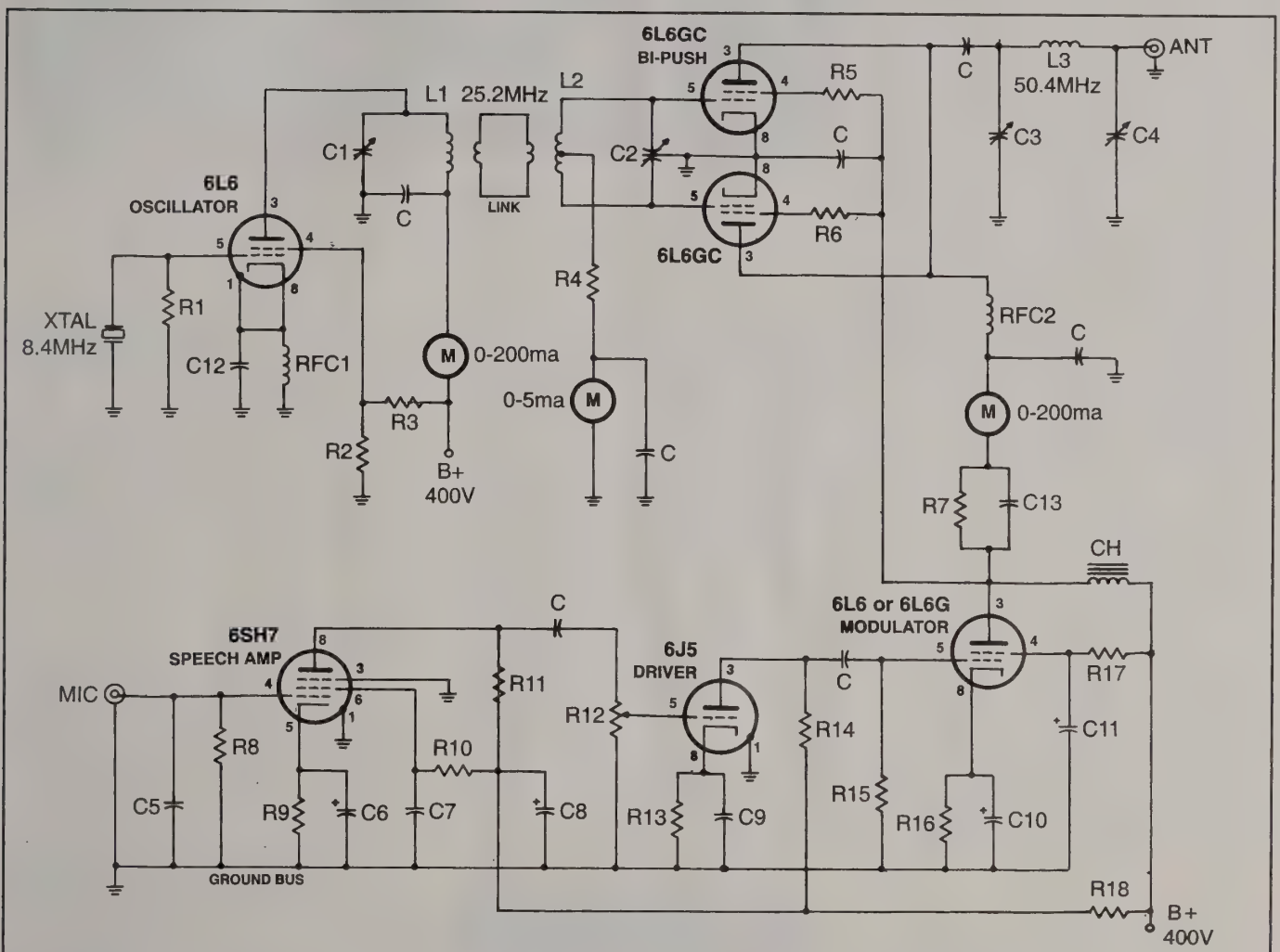
Photo A. The 6-meter radiotelephone station. Left to right: speaker-microphone, transmitter, antenna coupler and SWR meter, receiver, and speaker. (Photos by the author)

tubes, and amplitude modulation using the Heising (see sidebar) principle.

Crystal Oscillator

After trying several crystal oscillators, a 6L6 circuit shown in the 1938 *Jones Radio Handbook* was selected, providing good third harmonic output from an 8.4-MHz crystal. This circuit utilizes the capacitance of the metal shell of a 6L6 to its plate as a feedback capacitor by connecting pin 1 to the cathode, pin 8. If a 6L6G (glass tube) is used in place of the older metal type, a capacitor of about 15 pF must be connected from cathode to plate to provide the necessary feedback. Although this circuit works a crystal harder than a rented mule, RF crystal current, as measured by connecting a 60-ma pilot lamp (#48 or #49) in series with the crystal, proves that the current is below 80 ma. Crystal current above 80 ma may fracture an FT-243 type crystal. Oscillator plate current runs about 65 ma at 350 volts.

To provide good harmonic energy, the 6L6 oscillator tank circuit should be low capacitance. Output from the 6L6 oscillator tank, 25.2 MHz, is taken via link coupling to the push-pull input tuned circuit of the bi-push doubler. Link coupling is simple, is the most efficient means of power transfer between two tuned cir-



Parts List—Transmitter

C: 0.002 µF 1 KV
C1: 50 pF variable
C2: Dual section 50 pF variable
C3: 50 pF variable
C4: 250 pF variable
C5: 100 pF
C6: 10 µF 25V
C7: 0.1 µF
C8: 10 µF 450V
C9: 1.5 µF
C10: 10 µF 25V
C11: 10 µF 450V
C12: 250 pF
C13: 2 µF

R1: 50K 1/2W
R2: 65K 20W
R3: 6k 10W
R4: 75k 1/2W
R5, R6 : 33K 1/2W
R7: 1K 10W
R8: 1meg 1/2W
R9: 1.8K 1/2W
R10: 500K 1/2W
R11: 220K 1/2W
R12: 500K pot
R13: 2.7K 1/2W
R14: 100K 1/2W
R15: 500K 1/2W
R16: 500 ohm 5W
R17: 20K 10W
R18: 10K 1W

RF Coils (see text)
L1: 19 turns #14, 1/2 inch ID, 1 3/8 inches long
L2: 24 turns #14, 1/2 inch ID, 2 inches long
L3: 7 turns #14, 1/2 inch ID, 5/8 inches long

Chokes
RFC-1, RFC-2: Ohmite Z-50 (see text for construction details)
CH: About 10 Hy, 150 ma (not critical)

Figure 1. Schematic of the 6-meter transmitter.

cuits, provides excellent rejection of spurious and harmonic frequencies, and avoids RF return current from stage to stage through the chassis. All oscillator ground returns are made with short leads to a single point on the chassis.

Power Amplifier

A split-stator variable capacitor is used in the push-pull input circuit to assure balanced drive of over 2 ma to the 6L6GC grids. A 33-ohm resistor is connected in series with each screen-grid lead to help balance the tubes and prevent spurious oscillation. A pi-network output tank circuit provides good impedance match from the parallel-connected or bi-push 6L6GC plates into a nominal 50-ohm coaxial antenna feeder. Output capacitance is about 150 pF at resonance, giving low shunt reactance to any spurious frequency components in the transmitter output. Plate current runs about 80 ma at 325 volts. Carrier output power is 12 watts to match the 7 watts of audio from the 6L6 modulator tube, although with 350 volts on the oscillator and 400 volts on the bi-push, power output is 20 watts.

Modulator

Heising plate-screen modulation was chosen because it is very simple, requiring only a common audio-frequency choke of non-critical value (such as a power-supply choke from a junk TV set) as a common impedance between the 6L6 class "A" modulator tube and class "C" RF amplifier. In the Heising system, if the modulator and RF amplifier utilize the same plate potential, 100% modulation of the carrier cannot be achieved. To raise the percent modulation, a 1000-ohm 10-watt resistor bypassed for audio frequencies by a 4-µF paper cap reduces the plate voltage to the power amplifier.

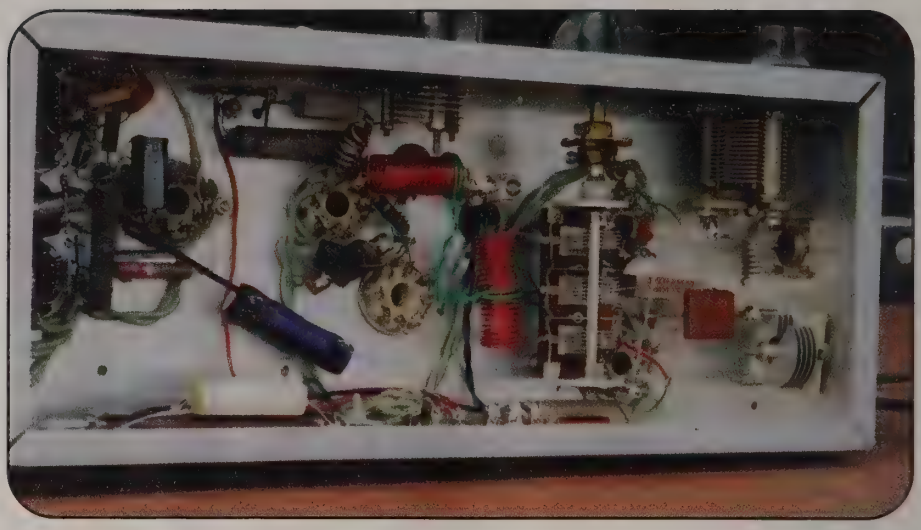


Photo B. Underside of the transmitter with the modulator on the left, oscillator in the center with its plate coil link-coupled to the push-pull grid coil with split stator cap, and the pi-net output coil with tuning and loading caps on the right.

A crystal microphone that delivers about 50 millivolts peak output was planned to be used. Therefore, a voltage gain of 360 was needed to swing the 6L6 modulator grid to the limit of its cathode bias, 18 volts. Design of the 6SH7 speech amplifier, voltage gain 230, and 6J5 driver, voltage gain 14, was taken directly from the *RCA Tube Manual, Resistance Coupled Amplifier Data.* To conserve sideband power while maintaining speech intelligibility in the audio spectrum of 500–2500 Hz, the following modulator design parameters were chosen: A 4-meg-ohm resistor at the 6SH7 grid limits bass response (higher value mic load resistance increases bass). Bass response and hum are further limited by use of small-value coupling caps of .002 µF. Treble response is limited by a 100-pF cap from the 6SH7 grid to ground. This bypass cap also keeps RF out of the modulator input. Audio gain is controlled by a 500K audio-taper pot (from a junk AC-DC radio) between the speech amp and 6J5 driver tube.

Power Supply

Power requirements for the transmitter and modulator are 350 to 400 volts DC at 200 ma. A power transformer and filter choke from a junk tube-type TV set easily fills the bill, with four 1000-piv silicon diodes in a bridge rectifier circuit. To maintain B+ voltage regulation, the choke should have a DC resistance of 200 ohms or less. One section of filter in the power supply is sufficient; additional filtering for low-level modulator stages is provided by the modulator's decoupling circuit. Power supply filtering consists of a choke input followed by two 40-µF 350-volt filter caps in series to B–, each cap shunted by a 100K 2-watt resistor for voltage equalization.

My power supply has a 120-watt Variac connected to its 120-volt primary to adjust the power-supply output voltage to 350 VDC. The send-receive switch is in the 120-volt line to the Variac. When the switch is turned to TRANSMIT, the power supply is energized and a Dow-Key relay is also energized and switches the antenna from receiver to transmitter.

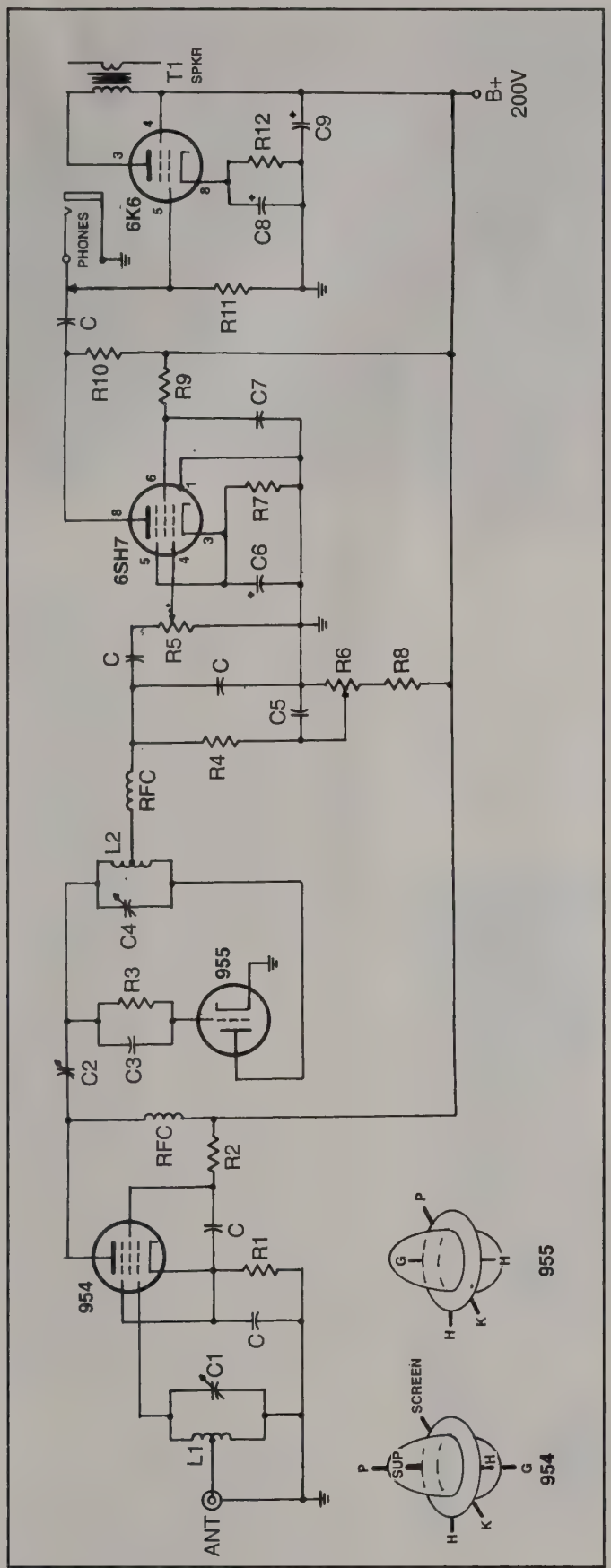


Figure 2. Schematic of the 6-meter super-regenerative receiver.

Auxiliary contacts on the Dow-Key mute the receiver. A separate 6.3-VAC heater transformer provides 4 amps to the transmitter's tube filaments.

Construction Hints and Tune-Up

A suitable chassis can be salvaged from a vacuum-tube TV set or from one of those huge, old console radios. A pressed-wood panel with holes cut with a coping saw will hold the meters.

All leads that carry RF must be short. RF ground connections in each stage should be made to a single point on the chassis. In the modulator section, all ground connections should be made to a common ground bus. This may consist of a length of #14 wire, grounded only at the modulator input (mic connector) and extending to the 6L6 modulator tube. Thus, cathode and grid returns of all three tubes in the modulator section connect to this ground bus to avoid hum currents and audio frequency feedback. Decoupling of the speech amp circuit is provided by a 10K resistor and 10-µF electrolytic cap.

It's best to first build the oscillator and get it working. At the oscillator plate current dip of 65 ma, a #47 pilot lamp with a two-turn loop, coupled to the B+ end of the oscillator plate coil, should glow to near full brilliance. With an 8.4-MHz crystal, oscillator output should be the third harmonic, 25.2 MHz.

Next, build the bi-push final amplifier and couple its grid coil to the oscillator with a twisted length of hook-up wire and two-turn link wound over the low RF potential point on each coil. With B+ off the amplifier, when the grid circuit cap is tuned to resonance, the oscillator should deliver about 2 ma grid drive to the push-pull grids. Now when B+ is applied to the amplifier with a 50-ohm dummy load, the bi-push plate current should

Parts List—Receiver

C: 0.002 µF 500V
C1: 15 pF variable
C2: 10–50 pF trimmer
C3: 50 pF
C4: 15 pF variable
C5: 0.1 µF 200V
C6: 10 µF 25V
C7: 0.1 µF
C8: 10 µF 25V
C9: 20 µF 350V

R1: 1.5K 1/2W
R2: 150K 1/2W
R3: 5 to 10 meg ohms
R4: 27K 1/2W
R5: 500K pot
R6: 100K pot
R7: 1.7K 1/2W
R8: 250K 2w
R9: 470K 1/2W
R10: 220K 1/2W
R11: 500K 1/2W
R12: 400 ohms 1/2W

Coils (see text)
L1: 16 turns #14, 1 1/4 inches long. Antenna tap 2 turns from ground end.
L2: 18 turns #14, 1 3/8 inches long. Center tapped.

RFC: Ohmite Z-50 (see text for construction details)

T1: Output transformer, 7.5K 6K6 plate to 4-ohm speaker. Not critical.

Photo C. Rear view of the transmitter: 6L6GC bi-push finals on the left, metal 6L6 oscillator tube, Heising modulation choke, and 6L6G modulator tube on the right.

dip to about 80 ma when the plate circuit cap is tuned to resonance and the loading cap is opened to about one-third mesh. Speaking into the microphone should *not* cause the plate current to flicker, but an RF voltmeter connected across the dummy load should show voice peaks, indicating that the modulator is working.

What? You don't have a crystal microphone? An excellent electro-dynamic mic can be made from a PM speaker and output transformer from a junk AC/DC radio. The output transformer was designed to match the nominal 4-ohm speaker impedance to the plate impedance of the audio output tube, typically a 50L6 or some such beam tetrode. In its new role as a mic, when you speak into the cone, the transformer will step up the voltage generated by the speaker to 100 millivolts or so to drive the transmitter's speech amplifier. The speaker-mic can be left in the original radio plastic cabinet, left open, or a small wooden box can be built to protect it. A one-pound coffee can stuffed with toilet tissue for acoustical damping, and holes punched in its lid, makes a suitable mic enclosure for a small speaker. I've received good reports on audio quality with such a setup, but it's easy to overdrive the modulator. Speak in a normal voice and keep the speaker-mic about 8 inches from you.

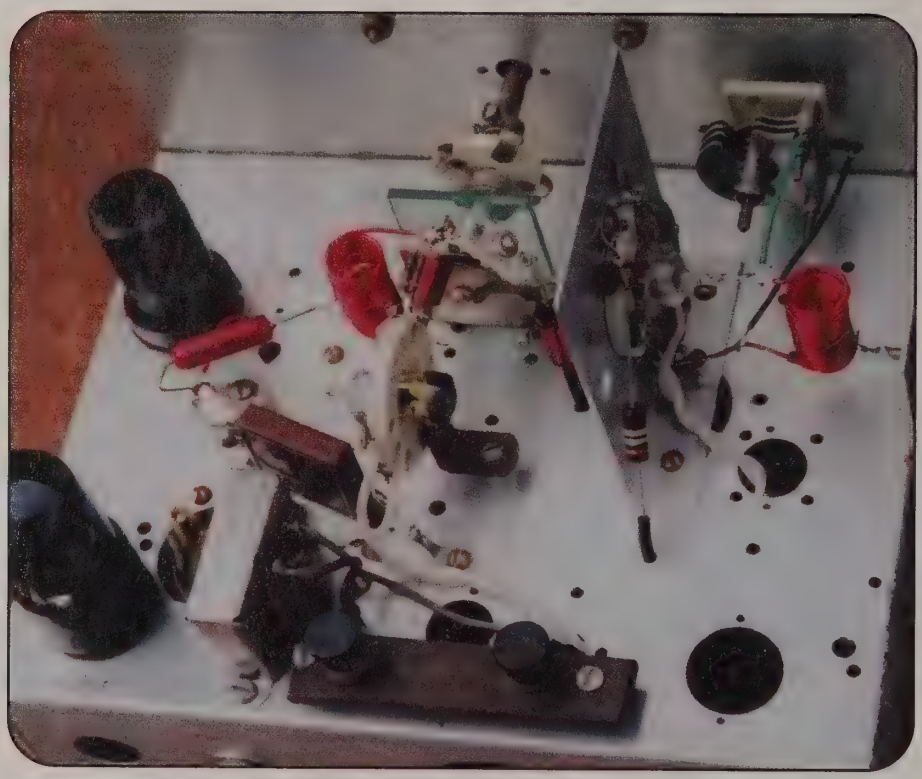


Photo D. The 6-meter super-regenerative receiver. Lower left is the 6K6 tube audio output; upper left, the 6SH7 audio driver; center is the 955 acorn detector tube with its center-tapped grid coil; next is 954 acorn RF stage and its antenna coil.

Receiver

The time-honored super-regenerative detector circuit of Major Armstrong, which is considered to be one of the most remarkable radio circuits ever devised, was selected for the receiver. To match the 955 acorn triode tube self-quenched detector to a nominal 50-ohm coax antenna feeder, a 954 acorn tuned RF stage was added. The best receiver noise figure that can be achieved with a tetrode RF stage at 50 MHz is about 4 dB. Triodes in a cascode circuit will do better if they are neutralized, but ambient noise on the 6-meter band is such that a 4-dB noise figure RF stage generally will reach the noise level.

Acorn tubes, developed by RCA in 1934, quickly revolutionized UHF receiver design. Acorns are still available, although a 6AK5 and 6C4 will serve as well. In operating the receiver, as the regeneration control is advanced, the 955 acorn detector begins to "supe" at a plate potential of only 4 volts. Due to the low voltage, radiation of super-regenerative energy is minimal; however, despite the buffering action of the RF stage, the hiss can be heard on a nearby receiver tuned to 6 meters. A 6SH7 high-gain audio amp followed by a 6K6 power pentode provides loud-speaker reception. A headphone jack mutes the speaker when 'phones are plugged in.

Construction Hints

*ARRL Handbook*s of the 1930s, particularly the 1936 edition, contain a good discussion of super-regenerative receiver design. Salient points are: All detector ground connections to a single point on the chassis, low-C tuned circuits for both

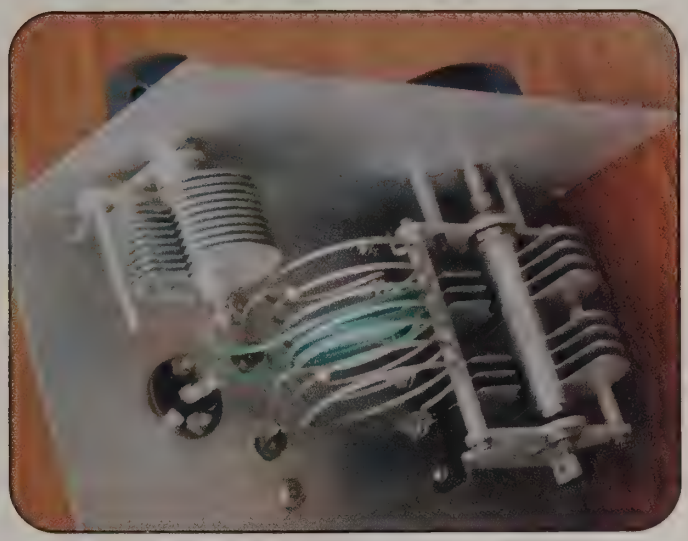


Photo E. The balanced antenna coupler (design from ARRL VHF Handbooks*)*

RF stage and detector, and heavy loading of the detector by the RF stage. The most critical component in a super-regenerative detector circuit seems to be the grid leak. Typical values are 2 to 10 meg-ohms. Experiment with various grid leak values to give the smoothest transition into super-regeneration when the control pot is advanced. Receiver power supply requirements are 180 to 250 VDC at about 50 ma and 6.3 VAC at 1.5 amps.

The coils for both transmitter and receiver are wound of bare #14 wire stripped from "14-3 Romex." The wire is wrapped around into the threads of a 1/2"-13 machine bolt. Then the coil is "unscrewed" from the bolt and stretched until the turns are spaced about one wire diameter. Stretching the coil to a longer length will increase its inductance (lower the tuned circuit resonant frequency) and vice-versa.

RF chokes for both transmitter and receiver are made by close-winding 45 turns of #30 enameled wire on old-style (5/16 inch diameter) 2-watt carbon resistors of 100K ohms (or more). Winding length is one inch. Solder the winding ends to the resistor axial leads. Coat the chokes with clear finger-nail lacquer to hold the wire in place. This design, shown in "G.E. Ham News," Jan.–Feb. 1949 (Vol. 4 #1) p. 6, approximates the "Z-50" RF chokes that were produced by the Ohmite Mfg. Co. The chokes can also be wound on 5/16-inch diameter sections of plastic pen barrel.

Conclusion

A completely homebrewed amateur rig, from microphone to antenna, is a fun project that will spark hours of discussion on the air. Although the Heising modulation system works well, the 1000-ohm resistor in series with the RF amplifier wastes carrier power, and the modulator is limited to a class A stage. Plate modulation could easily be incorporated by using an old TV power transformer as a modulation transformer. The high-voltage center-tapped secondary could be connected to the push-pull plates of the modulator tubes in an efficient class AB-1 circuit, with the 120-volt primary connected between the class C amplifier plate and B+.

The remarkable super-regenerative receiver has surprising sensitivity, and gives an "automatic volume control" action to amplitude-modulated signals. CW code signals cannot be satisfactorily received, but FM signals can be received by slightly detuning the receiver to provide "slope" detection. What? SSB on a super-genny? Yes. My 100-kHz crystal calibrator puts out signals every 100 kHz throughout the 6-meter band. The SSB portion of the West Michigan Six Meter Net is conducted on 50.3 MHz. By tweaking the 100-kHz oscillator frequency and adjusting the signal injection level into the receiver's antenna terminal, I'm able to copy SSB transmissions on my super-genny quite well.

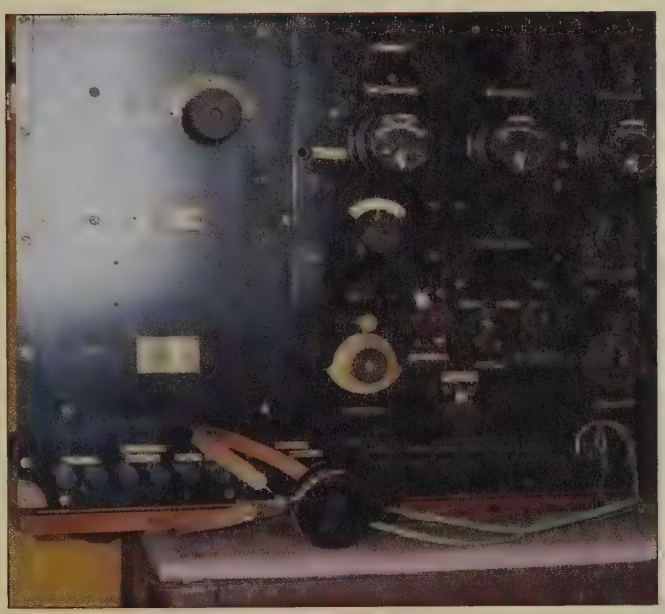
The Birth of Audio Modulation and the Radio Transceiver

In 1917, the US Navy contracted with Western Electric Co. to design and build radiotelephone transmitter-receivers. These "transceivers," first used for communication between submarine-chaser ships, were the first radios to use voice modulation of a CW carrier. They were built at Western Electric's Hawthorne Works in Cicero, Illinois. Two hundred of these CW 936 transceivers were installed on combat vessels. The constant current modulation principle was developed by Electrical Engineer Raymond A. Heising (M.S. University of Wisconsin,1914). Any one of five fixed frequencies between 500 and 1500 kHz could be selected by the radio operator. The receiver was a simple tuned-radio-frequency type without regeneration, as an oscillating regenerative detector radiates a signal that could be DFed by the enemy.

These "sub-chaser" transceivers heralded the beginning of radio broadcasting and long- and short-distance radiotelephony. They were in general use by the Navy until 1930.

The CW 936 set in the photo was purchased many years ago at a radio surplus shop on Courtlandt Street in New York City. The Courtlandt-Vesey Street "Radio Row" area of lower Manhattan later became the site of the World Trade Center.

Source of CW-936 information: Capt. L. S. Howeth, *History of Communications-Electronics in the United States Navy,* Bureau of Ships, 1963, p. 254.



CDE/Hy-Gain Rotors
How to Keep 'em Turning – Part 1

What is a beam without a rotor? What good is a broken rotor? W9FX has spent years repairing the CDE/Hy-Gain rotors. Here in part 1 of this two-part article, he shares his knowledge of rotor repairs. Next time he shares his knowledge of repairing the control box.

By Brad Pioveson,* W9FX

Bell-shaped rotors (or rotators, if you prefer) are as much a part of amateur radio as Morse code keys and microphones. Having the ability to remotely turn one's directional antenna and reliably knowing in which direction the antenna system is pointed when you release the switch is fundamental to being able to successfully work local stations or DX on HF, VHF, UHF, and microwave frequencies alike. What will you do when the rotor malfunctions? When—not if—it happens to you, you might find yourself grabbing the nearest ham radio dealer's catalog (or visiting the dealer's internet website), only to find that new rotor prices are a lot higher than they used to be—ouch! You might consider sending the rotor off to a shop that specializes in such work. That, too, can be a costly proposition, and you're without a rotor for days or weeks. Usually, if Murphy has anything to say about it, the rotor is either inoperative or out for repair during the biggest 6- and 2-meter *Es* openings of the past decade.

If you're looking to save both time and some money, aren't afraid to get your hands a little dirty, and have the ability to use a VOM, soldering iron, and common hand tools, this article is for you, as it will show you exactly how to take these rotors apart, install the most commonly needed new parts, and, reassemble the unit. Simple controller repairs will also be covered in Part 2. Armed with this information, some new parts, and your sweat equity, your trusty "antenna twirler" will once again be ready to provide you with many more years of trouble-free service.

For the purposes of this article, a "typical" CDE/Hy-Gain rotor will be the subject of the repair. The candidate is a CDE Ham II model. The same techniques, same tools, same parts[1], are used in the Ham M Series 3 and 4[2], the Ham III, the Ham IV, and the Ham V models. Additionally, the information also applies to the smaller TR-44, CD-44, CD-45, and CD-45 II units—with differences noted in the text where necessary. To save endless references to all these models, I'm going to refer to all of these rotors collectively as the "Ham X" series.

There are components in the Ham X rotors that need to be replaced after several years of service. This article is based on the assumption that your Ham X will need the following components replaced when you drag it onto your bench: azimuth potentiometer, terminal board, and bearings. This is not to say that other problems won't occur with your rotor. Spur gears have been known to lose teeth; final (ring) gears, especially the cast-aluminum type found in the older Ham X and CD/TR units can break; brake wedges have been known to fracture under extreme loads; and motors and/or their pinion gears will, although rarely, give up the ghost. The most common failures—and the replacement of the failed components—are discussed in this article. First, we'll examine the rotor units, then we'll look at a few of the more frequently occurring controller problems.

By the Numbers

The most common single failure item in the Ham X series of rotors is, undoubtedly, the azimuth potentiometer. Failure can present itself in a number of ways. Intermittent controller meter indications (needle "jitter") are the usual first symptom of a potentiometer problem. The design of the azimuth potentiometers has changed a little over the years, but until just the past few years the design featured a copper wiper-arm/moving-contact assembly that rode on top of the resistance wire wound around a molded, synthetic form. Oxidation of the copper wiper resulted in poor conductivity; hence, "meter jitter" was seen in many cases. Additionally, the resistance wire abraded the soft copper of the wiper, and even-

Tools
Vise, "Bench Mate," or similar device
VOM or multimeter with leads
5/16-inch diameter nut driver or socket
1/4-inch diameter nut driver or socket
Soldering iron and rosin core solder
Needle-nose pliers
Phillips screwdriver
Flat-blade screwdriver
Rags or paper towels
Degreasing compound

Parts
Azimuth potentiometer Hy-Gain part #5023100
Terminal board Hy-Gain part #5146510
10 ea. #6 × 1/2-inch stainless-steel machine screws
Bearings (98 ea. For Ham X; 49 for CD/TR) Hy-Gain part #5033501
Bearing retainers Hy-Gain part #5011300
Grease, approximately two tablespoons of white lithium or other low-temperature lubricant

Table 1. Tools and parts required for the rotor project.

**301 Kirsch Street, Benton, IL 62812*
e-mail: <w9fx@verizon.net>

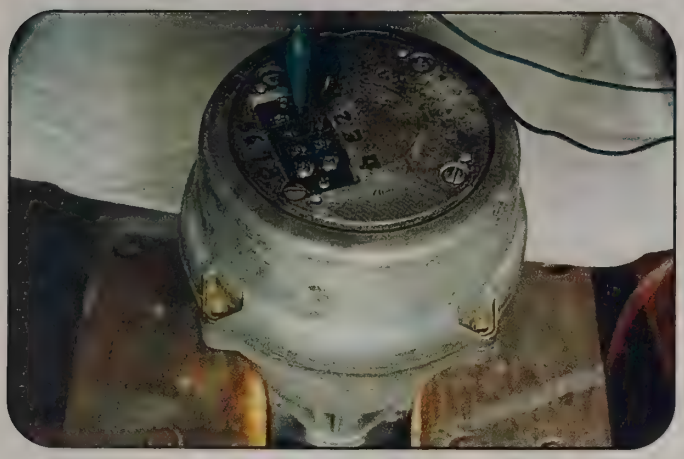


Photo 1. Turn the rotor upside down with the "Vee" of the mast bracket facing away from you, securing the rotor in a vise (see step 1). (All photos by the author)

Photo 2. Remove the four #12-24 screws that hold together the upper and lower halves of the rotor (see step 2).

Photo 3. Lift the brake housing (or retaining ring for the TR/CD rotors) straight up away from the rotor. The plastic spacer may come off and remain inside the brake housing (see step 3)

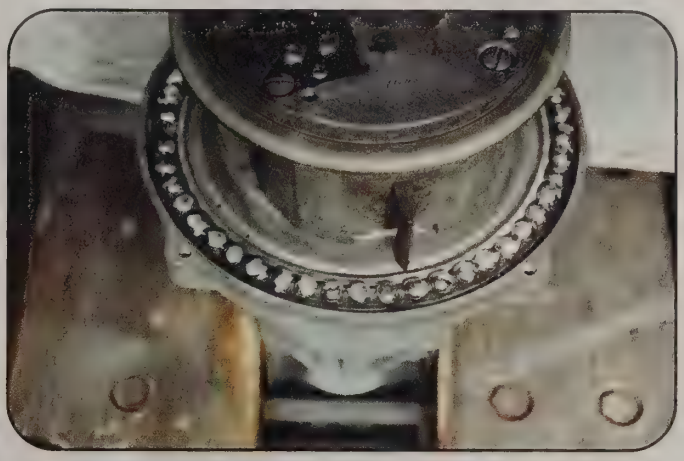


Photo 4. The plastic spacer (there is no spacer in the TR/CD units) may remain on the rotor unit, and it must be removed from the rotor or housing and set aside for cleaning and inspection (see steps 3 and 4).

tually completely ground off the end of the wiper arm, resulting in complete potentiometer failure. Hy-Gain has addressed these problems with the latest design change to the potentiometers. Since about mid-2005, the OEM potentiometers' wipers are equipped with a silver-plated rivet affixed to the end of the wiper. The rivet makes contact with the resistance wire, thus eliminating both the abrasion and oxidation problems (silver oxide is conductive).

Almost as common, and certainly the most frustrating, source of failure of these potentiometers is an operator-induced wiring error at the controller. It's easy to transpose wire colors on the 8-position terminal board and in so doing inadvertently apply 26 VAC to the potentiometer. Instant failure is the result as the potentiometer's winding melts. The smoke, however, isn't readily apparent, as it's released on top of the tower.

Another item that commonly fails, especially in older Ham X rotors, is the 8-position terminal board. That's the terminal board found on the bottom of the unit where you wire up the 8-conductor (7-conductor for TR/CD units) cable to the controller. The early units used a phenolic board with plated hardware. Few of these are still usable after 35 or 40 years of service. More modern units consist of a black plastic barrier strip. These plastic factory replacements hold up better than their predecessors, but unfortunately, they are still equipped with cadmium-plated steel screws. After a few years, or months in the case of corrosive environments, the plated hardware rusts. Intermittent or open circuits are usually the result.

The solution to the terminal board hardware rusting problem is to purchase a factory-new terminal board, and once it's in hand, remove all the screws, throw them away, and, replace them with equivalent-size (#6) stainless-steel hardware. The expenditure of a couple of dollars at the local hardware emporium is an investment that will repay you with years of future rotor service without wiring and/or conductivity issues at the terminal board!

Finally, if your rotor has been in service for some time, and especially if you live in a coastal area, your rotor will probably benefit from the replacement of its 98 (or 49 in the TR/CD series units) bearings. These plated steel balls will rust, and the aluminum/ferrous-oxide reaction can seriously erode the aluminum races of the rotor housings.

OEM Hy-Gain replacement parts are readily available from

Photo 5. The bearing set, one of two. This one is caked with dirt and grease (see step 5).

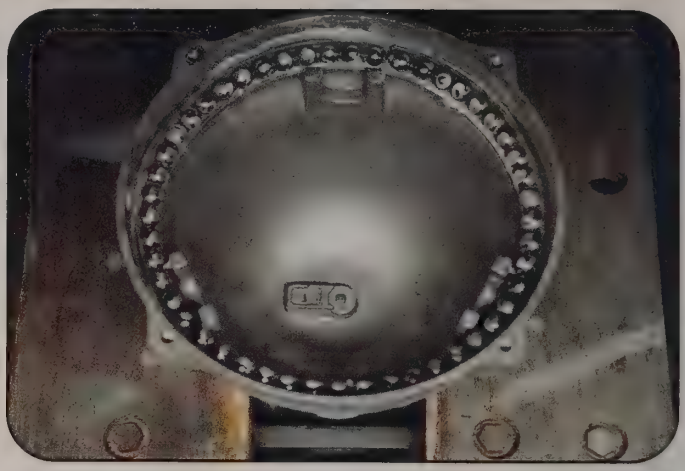


Photo 7. The upper housing with bearing set in place (see step 7).

Photo 6. The ring gear shown in place (see step 6).

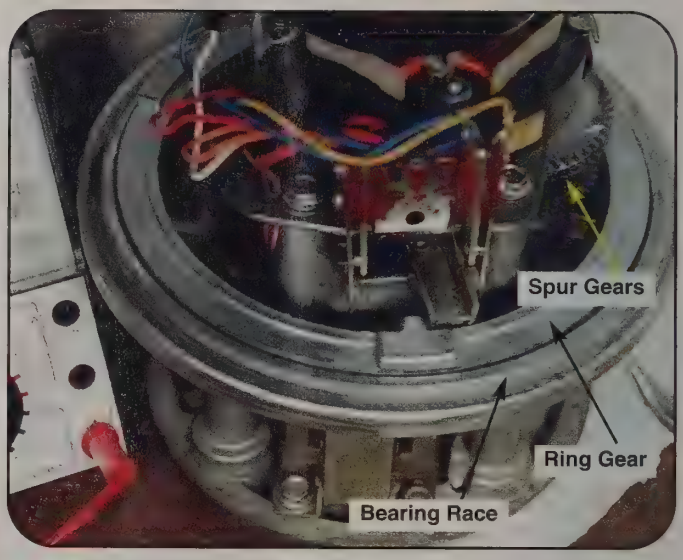


Photo 8. The spur gears, ring gear, and bearing race (see step 11).

both Hy-Gain[3] and 'The Rotor-Doc."[4] Manuals for current models of Hy-Gain rotors can be downloaded for free from the Hy-Gain website. Manuals for older CDE/CDR and Hy-Gain rotors are available for download from the BAMA website.[5]

Table 1 is list of tools and parts that will be needed for this project. *Note:* Disassembly and reassembly of the rotor will take place with the rotor in an inverted position. To do otherwise leads to a rather frustrating chase for the dozens of 3/8-inch diameter steel bearings housed within the rotor clattering to the floor of your workspace.

Following are the steps for repairing the rotor:

1. Turn the rotor upside down, with the "Vee" of the mast bracket facing away from you. Secure the rotor in a vise or similar holding device (photo 1).

2. Using the 5/16-inch diameter nut driver or socket, remove the four #12-24 screws that hold together the upper and lower halves (lower ring on the TR and CD rotors) of the rotor (see photo 2).

3. Lift the brake housing (or retaining ring for the TR/CD rotors) straight up, away from the rotor. Note that the plastic spacer may come off with and remain inside the brake housing (photo 3), or, it may remain on the rotor unit (photo 4). In either event, separate the spacer from the rotor or housing and set it aside for inspection and cleaning. (There is no spacer in the TR/CD rotors)

4. Once the brake housing (or retaining ring) is out of the way, you will see the lower bearing set exposed. Removal of this bearing set is quite easy, but if done carelessly it can lead to much frustration as you chase the 3/8-inch diameter steel ball bearings across your shop floor! Referring again to photo 4, if you carefully insert a flat blade screwdriver under the plastic bearing retainer, you can then grasp the bearing retainer with one hand. Lift it carefully, straight up. As you lift it, grasp the bearing retainer with your other hand so that you're supporting the retainer in two places, approximately 180 degrees apart. If you've done your job well, and the retainer is not damaged or stretched, the balls will stay in place.

5. Lay the bearing set on a flat surface; a workbench with a few paper towels or rags will minimize the mess (photo 5).

6. Grasp the bottom of the rotor assembly (as you're looking at it, it's now the top surface) and lift it straight up and out of the bell housing. Turn it over and place it on your work sur-

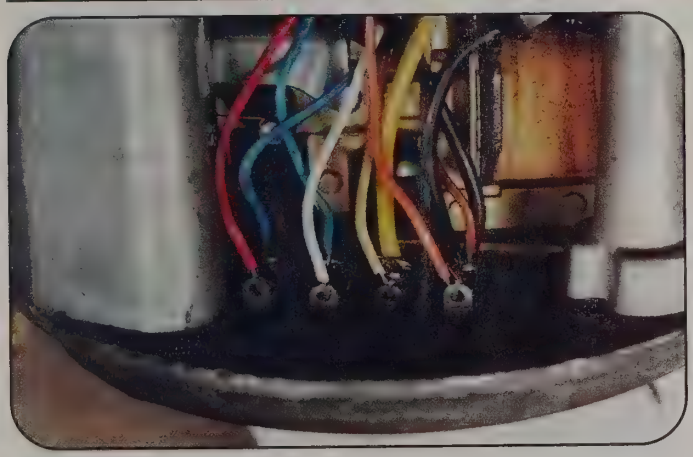


Photo 9. Terminal board and wiring viewed from the side of the rotor unit (see step 14).

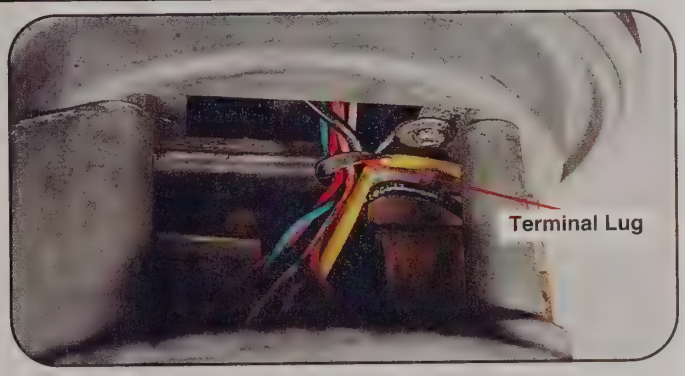


Photo 10. The terminal lug (see step 16).

face. The ring gear may dislodge itself at this time. That's OK; remove it completely and set it aside. If it stays in place (photo 6) that's OK, too, as we'll be removing it soon.

7. Using the same procedure outlined in step (4), remove the bearing set from the bell housing (photo 7).

8. The bell housing may now be removed from the vise. Remove the old lubricant with a degreasing compound. Dry the housing and set it aside.

9. Remove the old lubricant from the brake housing (or retaining ring for the TR and CD rotors). Use a stiff brush to clean the residue from between the teeth of the brake housing.

10. Set the brake housing (TR- and CD- series rotors, the retaining ring) aside.

11. Using a small, flat blade screwdriver, gently lift the ring gear out of the motor/gear base unit. You may have to move the ring gear (by manually rotating the top left spur gear) to allow the ring gear's protrusions to safely pass by the spur gear set (photo 8).

12. Clean and degrease the ring gear and set it aside.

13. Clean and degrease the rotor unit's upper and lower races and gear race.

14. Turn the rotor unit on its side to allow access to the terminal board (photo 9).

15. Over time, it is possible that the insulation may no longer be the same color as it once was; it fades over time and with exposure to the some lubricants. At the terminal strip end, blue can appear to be white, as can green, yellow, and orange! Make

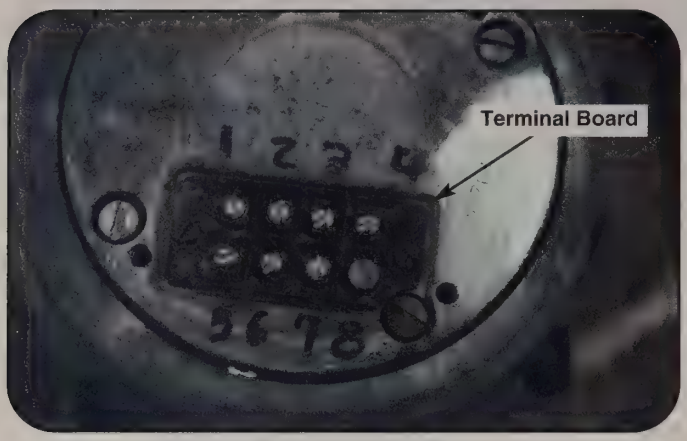


Photo 11. The terminal board (see step 18).

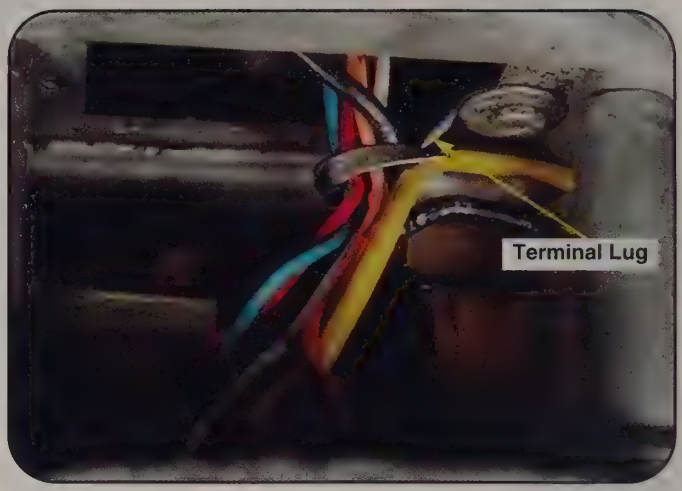


Photo 12. Secure the lugs in place with the solder lug as shown (see step 21).

yourself a chart of wire colors and terminal numbers so that you can properly rewire the new terminal strip. The color code that CDE and Hy-Gain used when they built your rotor is:

1 – Brown, Black, Black (black from rotor motor and black from brake solenoid)
2 – Large Yellow wire (from brake solenoid)
3 – Green
4 – Blue
5 – Orange
6 – Small Yellow
7 – White
8 – Red

Note that terminal 2 on TR and CD series rotors has *no* connection, and that terminal 1 on TR and CD series rotors only has two (one each, Brown and Black, wires connected).

16. Using the needle-nose pliers and soldering iron, carefully unsolder each of the wires from the terminals. If you need more room to work, you may bend the terminal lug that's used as a wire guide to allow the wires to be fanned out a bit photo 10).

17. Clean up the wire ends as necessary and prepare them for reconnection to the new terminal board.

18. Using a flat-blade screwdriver, remove the two screws that hold the old terminal board in place. Discard the old screws and terminal board (photo 11).

19. Set the new terminal board in place, making certain that the notch molded into one corner of the terminal board is situated as shown in photo 11. Install the new terminal board using the two stainless-steel, Phillips-head machine screws.

20. Working in sequence, and starting with terminal 1, attach and then solder the wires to the new terminal board.

21. Secure the wires in place with the solder lug as shown in photo 12.

22. Turn the rotor unit back upright on your work surface and orient it so that the wire connections on the old potentiometer are facing you. See photo 13.

23. Unsolder the green wire from the potentiometer. Using the needle-nose pliers, slide the insulating sleeve (if it's present) down the white wire to expose the soldered connection on the right potentiometer connection. Unsolder the white wire.

24. Using the 1/4-inch diameter nut driver or socket, remove the #6 nuts and star washers that retain the potentiometer. Note that you may have to move the wiper of the potentiometer in

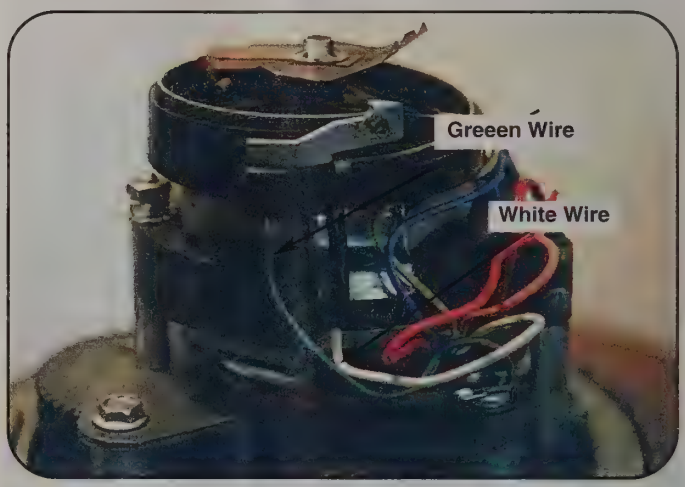


Photo 13. The green and white wires (see steps 22 and 23).

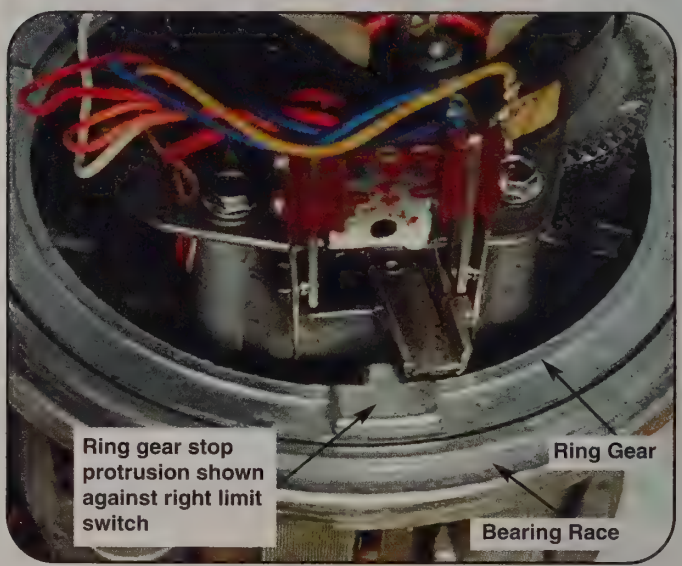


Photo 14. Set the ring gear in place such that the stop protrusion in located as shown (see step 29).

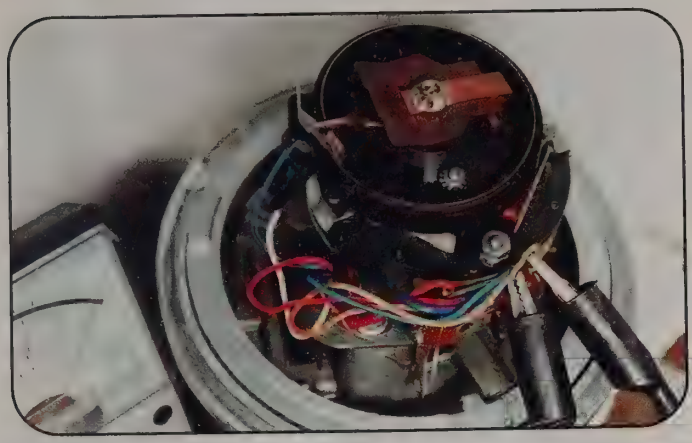


Photo 15. Set the VOM to ohms or continuity and attach the meter's leads to the terminals of the right-hand limit switch (see step 30).

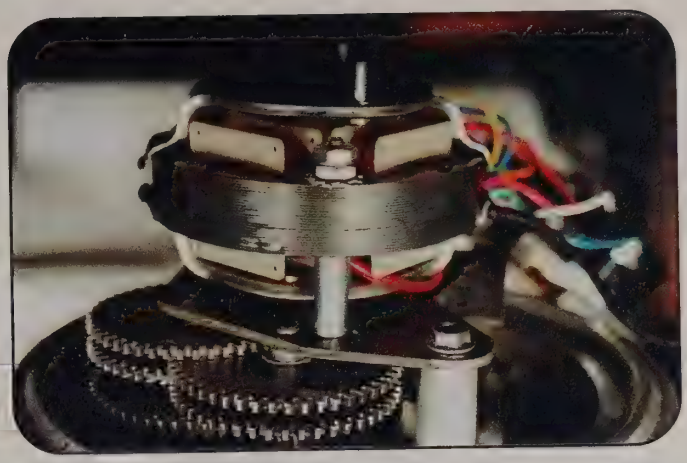


Photo 16. Turn the upper spur gear to move the ring gear (see step 31).

order to allow your socket or driver to fit onto the nuts. Once the hardware has been removed, lift the old potentiometer straight up and off the motor studs. There is a copper strap on the bottom side of the potentiometer that may resist being pulled off the motor stud. It can be "helped" with a screwdriver or with the needle-nose pliers.

25. The new potentiometer has three mounting holes. Only two of these will be used. Turn the potentiometer so that you are looking at its bottom side. There will be one hole on the left side of the potentiometer and two holes on the right. Rotate the copper grounding strap so that it aligns with the upper hole on the right side. Turn over the potentiometer and place it on the two motor studs, making certain that the copper strap is properly seated on the right-hand motor stud.

26. Secure the potentiometer using one of the star washers and nuts previously removed. Tighten firmly, but do not overtighten these nuts, as too much torque will damage the potentiometer's plastic housing! Again, you will have to carefully move the wiper arm to allow your tools to gain access to the both retaining nuts.

27. Solder the green wire to the left-hand potentiometer connection and the white wire to the right-hand connection. Note that the new potentiometer has a much shorter soldering lug than your old one might have had, and you may have to pull up a bit of the white wire to have enough to reach the new, shorter lug. Once you've completed the soldering, looking down at the top of the rotor, *rotate the potentiometer's wiper to the extreme counterclockwise (CCW) stop.*

28. Apply a thin layer of grease to the ring gear. Also, at this time, apply a thin layer of grease to the gear race—that is, the "groove" in which the ring gear rides, in the rotor unit assembly.

29. Set the ring gear in place. Try to orient the ring gear such that the stop protrusion is located as shown in photo 14. Note that some care and, often wiggling, is necessary to allow the ring gear to clear the upper spur gears and drop into place. The gear, when properly seated, should sit fully down in the race, and the ring gear's teeth should fully engage the mating teeth of the final spur gears. If you can rotate the ring gear with your fingers after you've set it in place, it isn't installed correctly. It should only move when you rotate the entire gear train!

30. Set your VOM to ohms or continuity, and attach the meter's leads to the terminals of the right-hand limit switch

Photo 17. Note that the potentiometer's wiper arm points to your left. There is a thin layer of grease around the bearing surface. (See step 33.)

Photo 18. Lightly lubricate the bearing sets (see step 37).

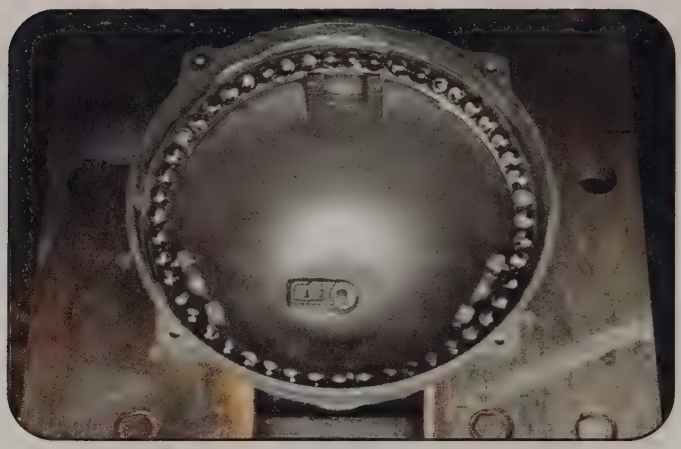


Photo 19. The bearing is set in place, flange up, and the sockets are engaged by the ring-gear mating protrusions (see step 38).

(photo 15). You should see continuity (zero, or nearly zero ohms) on the meter.

31. With your fingers or thumb, turn the spur gear shown in photo 16 counterclockwise until the stop protrusion of the ring gear contacts the arm of the right-hand limit switch and just opens it, as seen on your VOM.

32. Set the rotor unit aside.

33. Place the upper housing in the vise, again. The "Vee" of the mast bracket should be pointed away from you, and at the top of the inside surface of the bell housing, the fixture that contacts and drives the potentiometer's wiper arm should be pointed to your left. See photo 17.

34. Apply a thin layer of grease to the inside bearing surface of the upper housing.

35. Apply a thin layer of grease to the bearing race inside the brake housing (retaining ring on the TR and CD series rotors).

36. Lay out the new bearing retainers on a flat surface. The flanges of the retainers should be down. Each retainer will hold 49 ball bearings. Place one ball in each retainer slot. (For TR and CD series rotors, one bearing goes in every other slot.)

37. Using a finger, apply a very small dollop of grease on each of the balls in both bearing sets. We're looking for lubrication here, not trying to drown the bearings in grease! See photo 18.

38. Turn over one of the bearing sets so that the flange is facing up. Using both hands, carefully pick up this bearing set and set it in place inside the upper housing. See photo 19.

39. Check the rotor unit to make certain that the potentiometer wiper is still at the extreme CCW stop and that the ring gear has not moved and is still holding the RH limit switch in the "open" position. Grasp the rotor unit with both hands, taking care not to allow the ring gear to fall out of position, turn it over so that the ears of the potentiometer wiper are facing your left, and lower the rotor unit into the upper housing. The dogs on the ring gear should drop into the sockets cast into the upper housing. It may take you more than one try to accomplish this, and if so, be certain to check, before each attempt, that you have not changed the positions of the ring gear or potentiometer wiper or that one (or more) of the bearings has become dislodged from the retainer and is now lying loose in the housing! If you have successfully engaged the sockets with the ring gear dogs, you will not be able to turn the rotor unit (the part you just lowered into position); it will be solidly locked in place. If, however, the unit moves (in one direction or the other), remove the rotor base and try again, as you missed the dogs.

40. Once the rotor unit has been seated in the upper housing, apply a thin film of grease to the exposed race on the bottom of the rotor unit. Again, using both hands, set the remaining bearing set in place. This bearing set should have the *flange down* (photo 20).

41. Install the plastic spacer on the bottom of the rotor unit. See photo 20.

42. Using a finger or two, depress the brake wedge enough to slide the brake housing past it and onto the rotor unit (again see photo 20). Once the brake housing has been lowered in place, it is engaged by the brake wedge and you cannot turn the brake housing to align the bolt holes of the upper and lower housing halves. To do this, the brake must be electrically disengaged. (TR and CD series rotors have no brake. The retaining ring may simply be set in place and rotated, as necessary, to align bolt holes and the screws may be installed at this time.)

43. Attach wires or jumpers from the rotor controller's terminals 1 and 2 to terminals 1 and 2 of the rotor and disengage the brake (on Ham-II/III/IV controllers, this involves pressing and holding the center lever switch. On Ham-M controllers, this involves pressing and holding the lever switch to the left or right of center). With the brake disengaged, you may rotate the brake housing and align the bolt holes. If you have properly aligned the bearing retainer flanges and the ring gear is properly seated in the housing sockets, there should be no appreciable gap between the upper and lower housing halves of the rotor (photo 21). If, however, there is a gap of $^{1}/_{16}$ inch or greater, disassemble the rotor, find the problem (which is usually that one, or both, of the bearing sets has been installed upside down), and correct it.

44. With the brake still disengaged, install and tighten the four #12-24 screws that hold the upper and lower halves of the rotor together (photo 22). *Do not over-tighten these screws, as failure to heed this warning will result in stripped threads in the upper housing.*

45. With the rotor still in the vise, remove power from the controller and attach the remainder of the control wires to the

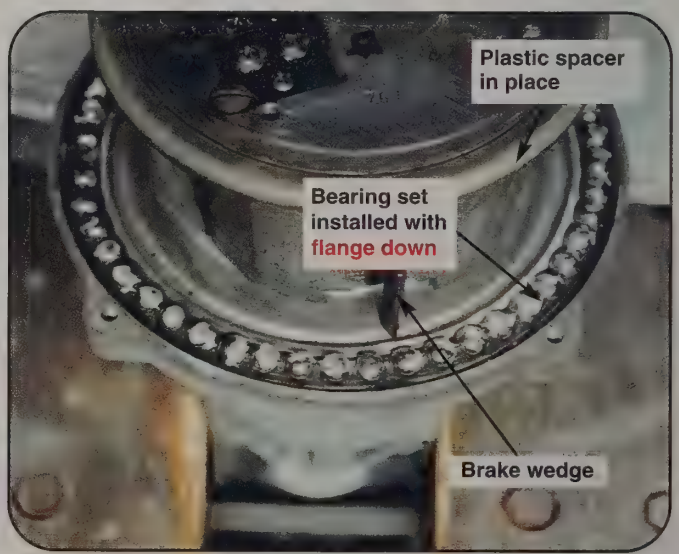


Photo 20. The plastic spacer is in place, the bearing set is installed with the flange down, and the brake wedge is in position (see steps 40, 41, and 42).

Photo 21. There is no appreciable gap between the two halves of the housing (see step 43).

appropriate terminals. Apply power to the controller and operate the rotor through a full 360-degree rotation. The meter should, initially, show full CCW ("South" on a typical indicator unit) and move smoothly to the opposite end of travel limit switch. At the end of rotation, the unit should shut itself off as it contacts (and electrically opens) the limit switch.

46. Congratulations! You've completed your work!

About Quick-Disconnects

There are those folks who believe that the convenience of having either Cinch-Jones connectors or round Amphenol connectors in the rotor with mating connectors installed on the cable outweighs the potential for water intrusion into these types of quick-disconnects. I am a strong proponent of using the standard 8-position terminal board at the rotor. Neither Cinch-Jones nor Amphenol connectors are easily waterproofed, and water intrusion into either of these connectors will lead to trouble. The circular Amphenol connectors, in particular, are troublesome. They are difficult to assemble, require a special, expensive, and, proprietary tool to disassemble (remove the contacts), and, they aren't really designed to handle the amount of current that the rotor's circuits can demand.

Here's an eye opener: I had a Ham III rotor disassembled on my bench one afternoon and wondered how high the AC current in the brake solenoid circuit would go if the brake wedge became fouled—if it couldn't move, in other words. Using a clamp-on AC ammeter, I measured 15+ amps of 26-VAC current flowing between terminals 1 and 2 of the rotor's wiring.

My suggestion, for those who wish to have a quick-disconnect near the rotor, is to use an OEM 8-position terminal board retrofitted with stainless steel hardware at the rotor. Construct a short pigtail of rotor cable. Equip one end of the pigtail with one of Press Jones's (The Wireman, Inc.) model 352 "8 pole molded connector, male and female set, heavy duty, weather proof."[6] Install the mating connector on the end of the cable that leads down the tower. Wire the 8 conductors of the rotor pigtail to the terminal board, cover the terminals and exposed copper wire on the terminal board with silicone grease (not silicone caulk!), and mount the rotor on your tower. Use spacers between the rotor and the tower mounting plate to allow water to run off and not make contact with the terminal board. For spacers, you can use stacked (stainless-steel) flat washers over the 1/4-inch diameter mounting hardware, or, you can use 5/16-inch or 3/8-inch diameter hex nuts. A 1/4-inch air gap here can make a lot of difference in the longevity of your electrical connections to the rotor. Hy-Gain also makes and sells a manufactured spacer to accomplish this task.

In Part 2 we will cover solving problems with the controller.

Photo 22. Prepare to align the bolt holes in the housing halves before installing the four housing screws (see step 44).

Notes

1. The gear trains of the various models differ, but bearings, potentiometers, and wiring are the same in all cases
2. The Ham M Series 1 and 2 rotors are unique in that their electrical wiring differed greatly from subsequent models.
3. <www.hy-gain.com>
4. <www.rotor-doc.com>
5. <http://bama.sbc.edu> and it's mirror site <http://bama.edebris.com/manuals/>
6. <http://www.thewireman.com/rotorp. html#351>

By Joe Moell,* KØOV

HOMING IN

Radio Direction Finding for Fun and Public Service

Transmitter Hunters Track Rockets in the Desert and Plan to Meet in Boston

Six months before I got my first ham radio license, I tuned my little Hallicrafters S-38D receiver to 20 MHz and heard the faint beep-beep signals that ushered in the space age. I was fascinated by rockets such as the one that put Sputnik into orbit, how they were propelled and how they were guided.

For me and for many others, that fascination continues into the 21st century. Tens of thousands have built and launched their own rockets, big and small, with help from organizations such as the National Association of Rocketry (NAR).[1] As it has gained in popularity, rocketry has become safer. The days of metal shells and mixed liquid propellants have given way to cardboard, plastic, fiberglass, and carbon-fiber frames with solid fuel sticks that can be purchased at hobby stores.

Serious "model rocketry" enthusiasts usually progress quickly into "high power rocketry" with motors that are too powerful to be purchased in shops. They don't achieve orbit, of course, but the really big ones can experience over 30 G's on liftoff, fly at super-sonic speeds, top out at heights of 15,000 feet or more, and parachute down several miles from the launch site. Since they aren't inexpensive, builders want to retrieve them. That's where amateur radio and transmitter hunting enter the picture.

Surrounded by their high-power rockets, Mark Melnyk (left) and Rob Foth, KE6YGF, carefully prepare seals that hold the solid fuel sticks in place. (Photo by Joe Moell, KØOV)

I'm Over Here

Some hobbyists outfit their craft with sound sources that activate on impact and beep loudly. Everybody possesses direction-finding equipment for audio, but range is limited to several hundred feet, and less if the wind is blowing strongly. Since anyone nearby can hear the beacon, rocket-napping isn't unheard of.

Over the years, a few companies have offered radio tracking systems using unlicensed transmitters on the 88–108 MHz FM broadcast band. However, the range of a Part 15 compliant transmitter on those frequencies is quite limited, especially in locations where the band is full of mountaintop transmitters running tens of kilowatts of effective radiated power. Licensed hams have much better alternatives. They can build their own mini-transmitters or buy them ready-to-use in the uncrowded 222- and 433-MHz bands.

Last spring Robert Foth, KE6YGF, of Glendora, California, brought me up to date on high-power rocketry and amateur radio for tracking. Rob had attended an on-foot international-rules transmitter hunt that I put on at Gladstone Park in 2005. He and his family took second place that day, but Rob was more interested in using radio direction finding (RDF) for "punching holes in the sky," as he puts it.

According to KE6YGF, "Our high power rockets cost hundreds, if not thousands, with their onboard altimeters and other costly systems. With the extreme altitudes they can achieve, I think having a tracking system is a must!"

At Rob's invitation, I visited a session of the Rocketry Organization of California (ROC)[2] at Lucerne Dry Lake, east of Victorville, California. Members gather there once a month to send rockets toward the heavens. When I arrived at 8 AM, 26 launch pads had been set up and members were busily assembling rockets of all sizes.

Of the dozen or so small groups that set up their sunshades in the desert that day, I saw only three that were using RDF for recovery. Two groups had 222-MHz transmitters and matching receivers from Communications Specialists of Orange, California.[3] I reviewed CommSpec's miniature "ditters" in Homing In in Spring 2008 *CQ VHF*.

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e-mail: <k0ov@homingin.com>

The BeeLine 433-MHz transmitter and quarter-wavelength antenna are dwarfed by a handie-talkie. The SMA antenna connector is a factory option. (Photo by KØOV)

Rob and Mark pack the Daisy Cutter's main parachute with help from Mark's son Jacob. The chute is powdered with talcum so it slides out easily. Inside is the BeeLine transmitter. (Photo by KØOV)

Rob has selected the BeeLine UHF transmitter by BigRedBee LLC of Lake Oswego, Oregon.[4] It puts out up to 16 milliwatts on a user-selected frequency between 420 and 450 MHz. Designed especially for rocket use, it operates for over 24 hours on a featherweight lithium-polymer cell. The entire shrink-wrapped battery/transmitter package weighs 30 grams (about an ounce).

With BigRedBee's serial port adapter and free software, BeeLine owners can use a PC with RS-232 port to reprogram the output power, frequency, and audio-tone parameters. The software also sets the user's CW callsign and an on-off sequence. BigRedBee owner Gregory Clark, K7RKT, sells this little rig only to licensed hams.

Rob told me about his initial experience with the BeeLine: "From the factory, it is set to operate at 433.920 MHz.[5] The callsign is sent in Morse every 30 beeps. Each beep is approximately 30 milliseconds long with 5-second pause between beeps. Not having time to configure the Beeline before the first launch, we used these default settings."

KE6YGF continued, "After launch, we thought we were tracking a strong but slightly distorted signal from the rocket. We drove over a mile with the bearing remaining constant. Only later did we figure out that our rocket had stopped transmitting and we were tracking something else, perhaps some kind of data transmitter on Big Bear Mountain. Luckily, a fellow rocketeer found our rocket while searching for his.

"After that, we changed the frequency and configured the Beeline for a much longer and more distinctive beep sequence. We also tested it on the ground first. With the Beeline in the rock-

Launch Control for Rocketry Organization of California is well equipped. The system can fire multiple rockets simultaneously for "drag races." (Photo by KØOV)

A high-power rocket lifts off at Lucerne Dry Lake. Launchers have sliding rods that aim rockets toward the sky, to land away from the observers. (Photo by KØOV)

et, one of us drove across the lake bed, intermittently stopping to set the rocket on the ground and see if the other still received a good signal at the launch area. This seemed to work well out to about 1.5 miles.

"The next launch was at night. The rocket landed about a half mile away and was easily tracked. Without an attenuator, we lost directionality when we were within about one-hundred feet away. At that point, I switched from the Yagi to the rubber duck on the receiver and tried some body-shielding and frequency-offset techniques. That got us within about 30 feet. Soon our flashlights and my Scout troop discovered the large parachute draped across the bushes."

Start the Countdown

The day of my visit was a big day for Rob, who was hoping to become certified as a Level 2 rocketeer by NAR. Like the third-party rules for ham radio, certified rocketeers are permitted to watch over uncertified persons as they launch, but most enthusiasts want to become certified themselves. There are many similarities between this certification and the VE program in ham radio. First, Rob had to take a multiple-choice, 33-question test on rocket design and construction, FAA, and fire-protection regulations, propellant storage and use, and other safety issues. He had studied the material from a question pool available online. The test was given and graded on the spot. Then he had to demonstrate proficiency by successfully firing and recovering his high-power rocket under the watchful eyes of a Level 2 holder, who would give final approval for his certification.

As Rob was sweating out his written test, his friend Mark Melnyk was assembling the first rocket, carefully inserting the fuel stick into the motor cylinder and sealing with new O-rings. Depending on motor size, each fuel stick costs $20 to $70. When Mark had it ready, he and Rob paid their fee, filled out a flight card, and took Daisy Cutter to a pad in the second row.

Rob and Mark's rockets are capable of mile-high altitudes. For a successful flight, the rocket must ignite and achieve the desired altitude, the parachute must open, and all parts must safely return to Earth and be recovered. If a full-size parachute were to open at one mile up, the descent would be so slow that the wind might carry it into the mountains. Therefore, Rob and Mark use a two-stage parachute system. A drogue chute opens at apogee and the rocket casing drops rapidly toward the ground. Then an altitude sensor fires a small gunpowder charge to open the main chute to slow the descent for landing. The altimeter also records the maximum-achieved elevation of the flight.

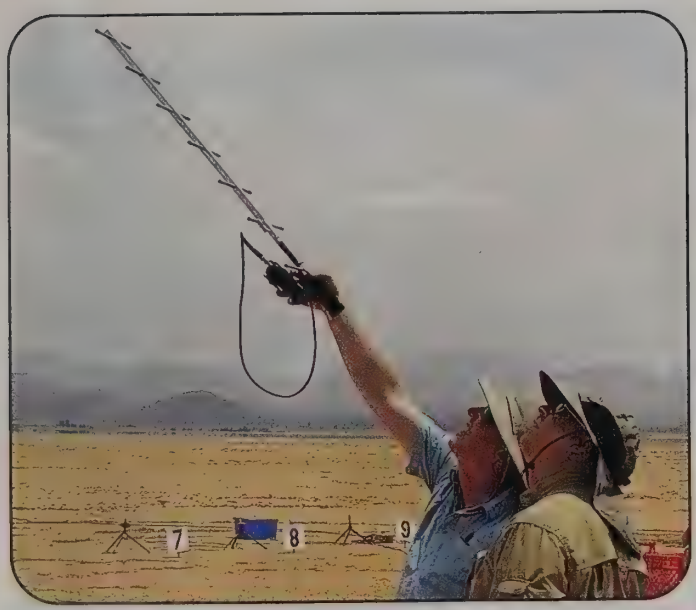
ROC has a well-planned procedure that efficiently executed the several dozen launches that I saw that Saturday. Groups of rocketeers attached their crafts to rods or rails on the pads and wired up the igniters. Then they retreated behind the firing line and Launch Control took over. On the public-address system, the controller announced the owner's name and rocket name, fired off the rocket, checked to make sure that the chute safely deployed, and then moved on to the next in rapid sequence until the pads were empty. After that, it was safe for the next group to go out, and so on.

Rob and Mark verified that the BeeLine was functioning before they left it on the pad. The predicted maximum altitude was about 6000 feet, so this flight was covered by ROC's blanket 8000-foot FAA clearance and they did not need special approval. The launch and ascent of Daisy Cutter was flawless. They got good bearings as it drifted down, and then they set off across the lake bed to retrieve it.

To track the BeeLine, Rob uses a 7-element Yagi (model 440-7) from Arrow Antennas in Cheyenne, Wyoming.[6] Arrow antennas are so named because the elements are made from aluminum arrow shaft material, which is significantly lighter than ordinary tubular aluminum of the same diameter. The signal into Rob's receiver is almost overpowering when the rocket is aloft, but drops dramatically once it reaches the ground. With the chute, it's easy to spot the rocket on the lake bed at a distance, but Rob knows that he needs to add attenuation to his system for close-in triangulation if the rocket were to be carried by winds into a vegetated area.

Rob passed his test and prepared Thunder Child for his certification flight, using the same altimeter and recovery transmitter that was on Daisy Cutter earlier. By then, the winds had picked up and the only rockets being launched were either small ones that wouldn't drift far or larger ones with recovery transmitters. Thunder Child shot up out of sight and the transmitter told Rob that it was coming down toward the northwest. With the binoculars they saw it land and headed out to pick it up, about a mile away. All the parts were together, so Rob was able to show everything and get his certification.

Rob's only complaint about the BeeLine tracking system regards the supplied lithium-polymer battery charger. He wrote, "It is a 'universal' type, which means that it does not fit any single application well. It comes with alligator clips that cannot connect directly to the battery pack. The user must either add his own connectors or insert small wires into the battery pack connector and then clip to the wires, creating a shorting hazard. Because the charger has non-polarized connectors, there is a test button to check the battery for proper polarization before



It's going that way! Rob and Mark are following the strong UHF signal just after launch. (Photo by KØOV)

plugging it into power. Another of the buttons on the charger allows you to reverse the polarity of the color-coded alligator clips. The red clip could be positive or negative!"

Since my visit, Rob and Mark have continued to advance their knowledge of rocketry. KE6YGF writes, "We have each built smaller diameter rockets that can easily fly over 10,000 feet. One of Mark's can exceed Mach 1 in the first few seconds of flight. Because these are impossible to visually track, I have purchased a second BeeLine. They are cheap insurance that we can locate expensive rockets in the miles of featureless desert playa. I am also experimenting with attenuators to help me keep radio-tracking when I get very close."

Properly packaged, the Beeline transmitter would be ideal for short-range, on-foot 70-cm foxhunts. Arnold Nelson, N6APA of Napa, California machined a rugged metal enclosure for his unit that is about 1" × 2" × 1/2" on the outside. He programs it for a 30-second on, 30-second off sequence for transmitter hunts of the Silverado Amateur Radio Society. Arnie calls it "The Littlest Fox."

Blue Hills of Beantown

I have good news for on-foot transmitter hunters in northeastern states. For the first time, our annual national championships of Amateur Radio Direction Finding (ARDF) will be close to you. Make plans now to be in Boston the first weekend of June for the Ninth USA ARDF Championships, which will be combined with the Fifth ARDF Championships of International Amateur Radio Union (IARU) Region 2 (North and South America).

Beginners and experts will gather on Friday for practice and equipment checks. Next will come two days of intense competition, Saturday on 2 meters and Sunday on 80 meters. Courses will be in the Blue Hills Reservation, a 7000-acre open space that straddles Interstate 93. It is about 10 miles south of the Old North Church in downtown Boston, which is another place that you will want to visit while you are in the "Cradle of Liberty."

This reservation is the largest conservation land within a major metropolitan area. It has 125 miles of trails that go

It's easy to follow the signal directly on the dry lake bed. There's no worry about staying on the road. (Photo by KØOV)

Vadim Afonkin, KB1RLI, will organize and host the 2009 USA and IARU Region 2 Championships near Boston. This photo shows him at the 80-meter starting line of the 2007 national championships near South Lake Tahoe, California. (Photo by KØOV)

through forests, marshes, swamps, and meadows, as well as an Atlantic white cedar bog. There are lots of hills, but altitude won't be a problem this year. The highest point in the park is only 635 feet above sea level.

Plenty of lodging and food options are close to the reservation. Expect daytime high temperatures in the 70s. As always, scheduled championship sites are off limits to anyone who will be competing, to avoid any unfair advantage of familiarity. Stay out of the reservation from now until the first day of competition.

Another first this year is the juxtaposition of championship ARDF and classic orienteering. Our ARDF event will take place at the same time as a local session (called a "B-meet") of the New England Orienteering Club and will use NEOC's excellent maps. Classic orienteers and radio-orienteers will share the finish area, but the ARDF start-point and electronic scoring will be separate. Flags at the hidden transmitters will have different markings from the orienteering controls to avoid confusion.

Besides reducing costs for everyone, the inclusion of ARDF

Vadim nears the 2-meter finish line of the 2008 ARDF World Championships in South Korea, where he won fifth place in his age category during the 80-meter competition. (Photo by Jay Hennigan, WB6RDV)

at the NEOC meet will expose orienteers and local Scouts to our radio sport. As always, the USA Championships are open to anyone who can run or walk through the forest while carrying RDF gear for 5 to 10 kilometers. A ham license is not a requirement. For the awards, competitors will be separated into age and gender categories in accordance with IARU rules. Category winners may qualify for positions on ARDF Team USA for the 2010 ARDF World Championships in the islands near Dubrovnik, Croatia.

Organizer and host of this year's national championships is Vadim Afonkin, KB1RLI, of Brookline, Massachusetts. Vadim learned ARDF as a youth in his native Russia. There he met a YL named Nadia, who later immigrated to America and became the first member of ARDF Team USA to win a medal at the World Championships.[7]

"My callsign in Russia was UZ3AYT," Vadim told me. "I started in 1982 and won my first bronze medal at the USSR championship in 1983. I became a member of the Soviet team in 1984 and ran at international competitions and later in military championships. I came to the USA in 1994 and brought my equipment. But I could not find any ARDF activity here, so I gave up. In one of my moves, my receivers got lost. Years later, Nadia called and told me about the new ARDF activity. She urged me to get involved. I had to get new equipment, but I did it."

Vadim first participated in USA's national championships in 2003 near Cincinnati, where he won silver and bronze medals in the five-fox M21 category. He has competed in M21 at every USA championships since then and has achieved the best five-fox time of all stateside participants in every one. As a member of ARDF Team USA, Vadim traveled to the World Championships in 2004 (Czech Republic), 2006 (Bulgaria), and 2008 (South Korea). In Korea, he took fifth place worldwide in the M40 category on 80 meters.

Our annual ARDF championships are an ideal opportunity to watch and learn from the best radio-orienteers in the country, as well as visiting experts from around the world. Each person competes as an individual; there is no teaming or person-to-person assistance allowed on the courses.Using GPS as a navigation aid is also forbidden.

Competitors are responsible for bringing their own direction-finding sets. Extra gear might be available for loan from other attendees, but inquire ahead of time. Receivers must not radiate signals that can be heard by others. Transmitting on the course is forbidden, except in emergencies.

Even if you aren't up to the challenge of a big-forest foxhunt, chances are that someone in your family or circle of friends is. Tell them about the opportunity and offer to help with RDF equipment and local practice sessions. All the basics are on my website[8], including the international rules and hidden-signal parameters. You will get equipment ideas for both competition bands and you can also determine your own age category. The pages of photos from our previous championships will help you decide what gear to carry (the lighter, the better) and what to wear.

Let's make this the biggest year ever for ARDF!

73, Joe, KØOV

Notes

1. <http://www.nar.org>
2. <http://www.rocstock.org/>
3. The new URL is <http://www.com-spec.com/rocket/index.html>
4. <http://www.bigredbee.com>
5. In the southern California band plan, this frequency is in the visual carrier range for NTSC ATV signals.
6. <http://www.arrowantennas.com>
7. The story of Nadia Scharlau's medal at the ARDF World Championships is in "Homing In," Fall 2006 *CQ VHF*.
8. <http://www.homingin.com>

By Kent Britain,* WA5VJB

ANTENNAS

Connecting the Radio to the Sky

Vivaldi Project

The most basic of beam antennas is the Vee beam. We just start with a dipole and form the elements into a V. Make the elements longer and longer, and the gain goes up. Make the elements really long, and there are advantages to tapering the separation between the wires. There also advantages to making the wires very fat and tapering the diameter, but we'll skip that this time and look at a sheet-metal version of the Vee beam.

Vivaldi Project

In photo A we have the a few of the Vivaldi antennas I have developed for various applications from 900 MHz to 35 GHz. The Vivaldi is one of a family of exponential antennas that work over a very broad range of frequencies. The basic antenna scales up or down very easily.

In photo B is a Ridged Horn. The ridges give a very broad frequency response to the horn. This model is rated at 2–18 GHz, but works from 1–20 GHz. In a way, we can think of a Vivaldi as a Ridged Horn minus the horn!

In figure 1 is the template for a Vivaldi antenna. If you just copy this template, your finished antenna will work from about 7 to 15 GHz or so. Ahh ... but if you put it on a copier, set the image to 200%, you get a template for a about a 3-to 10-GHz version . If you are really good working with small parts, set the copier to 50% and you have the template for a 10- to 25-GHz model. Your limits are the size of the sheet metal and your ability to trim very fine dimensions. The antenna is fed at the narrow end of the slot. Using sheet tin or sheet brass is nice because you can solder to it. For lower frequency designs it is possible to use sheet aluminum and attach some solder lugs, but using a material to which you can solder is nice.

Construction

My homebrew Vivaldi started with a 5-inch wide paper copy of the template. I cut the outline with scissors and stuck it on some old .031-inch PC board. As you

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e-mail: <wa5vjb@cq-vhf.com>

Photo A. Vivaldi antennas from 900 MHz to 35 GHz. (Photos and figures by the author)

Photo B. Ridged horn antenna.

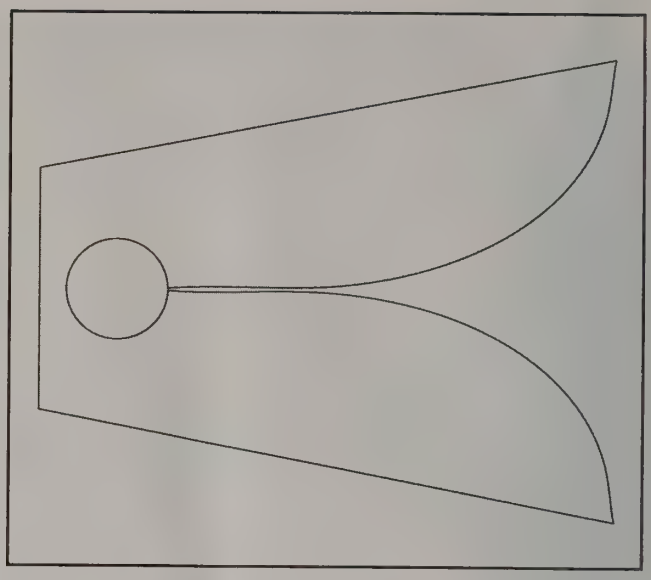

Figure 1. The Vivaldi antenna template.

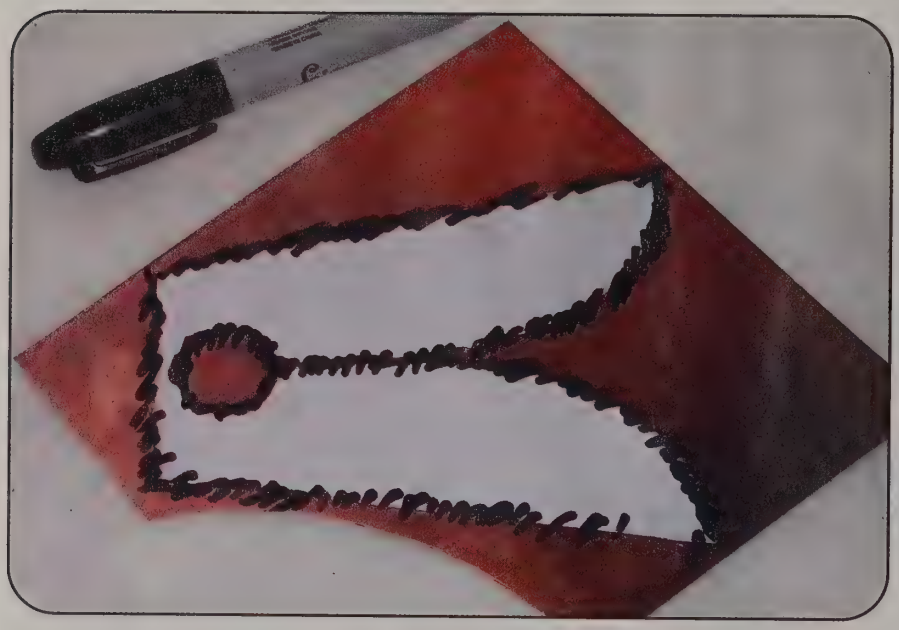

Photo C. Marking the template.

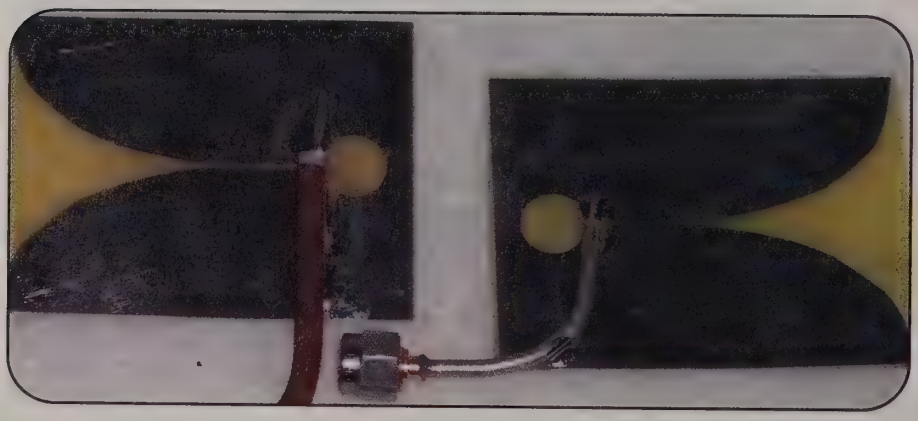

Photo D. Attaching the coax.

can see in photo C, I marked the edges and then cut it out. There are much better template marking techniques out there, and you are welcome to use your favorite transfer method. Next I cut the PC board again with scissors. The antenna doesn't care if it's single- or double-sided PC board. This also works for thin sheet metal. Then I took a few swipes with a file (sandpaper works, too). The antenna should not have sharp points sticking out along the curves. Sharp points can cause spikes in the SWR. Again you want the gap to be very narrow and the taper in the gap to be smooth.

I used simi-rigid coax to feed my PC-board versions in photo D and in the homebrew version, but any type coax that can be soldered can be used. This is usually one of the Teflon® insulation coax types. When soldering the coax, you want the shield right up to the gap, and the center conductor bent right down to the other side of the gap. The leads need to be very short, as we are talking many GHz here!

Testing of the finished antenna in photo E looked pretty good. In figure 2 is the return-loss sweep of the homebrew Vivaldi. The 5-inch version worked down to just under 1 GHz and still looked good at 6 GHz, the maximum frequency of my analyzer. Except for that spike at 1.8 GHz, the return loss is in the –10 dB to –20 dB range. Therefore, this one had a better than 2:1 SWR over the entire 1–6 GHz range—well, except at 1.8 GHz.

Again, the frequency limits are set by the how narrow you can make the slot opening, and the size of the flare opening. When we test them on an antenna range, the Vivaldi antennas have gain well below the frequency range shown in Table 1, but the return loss, or SWR, is high. Normally a Vivaldi antenna is fed 1/4 wave from the end of the slot. However, changing the slot to a circle greatly expands the SWR range of the Vivaldi.

There are other tricks to feeding this Vivaldi variation. If you have size limits, but need to use the antenna lower in frequency than in Table 1, you can move the feed forward as shown in photo F. You are getting the antenna to have a good SWR lower in its band, but the high frequency response pretty much goes away. This way you can make a 2- to 8-GHz version work at 1.5 or even 1.3 GHz, but above 3 GHz or so the SWR gets pretty high. It works, but you really need to measure the SWR when looking for that sweet spot and you are optimizing the antenna for one frequency.

Now on the high-frequency end, the limit is how accurately you can form the curve and the gap between the two sides. To improve the SWR on the high end you may need to block off part of the back as I have shown in photo G. I find small pieces of aluminum or copper tape are handy here, but again you really need to be able to measure the return-loss response or SWR using test equipment while tweaking the antenna. Now it is the low-frequency response of the antenna that is going to suffer. However, you can really lower the SWR/return loss on a narrow-frequency band.

Width of the end	Approx. Freq. Range
3/4 inch	18-35 GHz
1 1/2 inches	10-25 GHz
3 inches	4-20 GHz
5 inches	1-6 GHz
12 inches	400 MHz to 2 GHz

Table 1. The frequency limits of the Vivaldi antenna are set by the how narrow you can make the slot opening, and the size of the flare opening. When we test them on an antenna range, the antennas have gain well below the frequency range shown here, but the return loss, or SWR, is high.

Uses

These antennas make a nice test for a

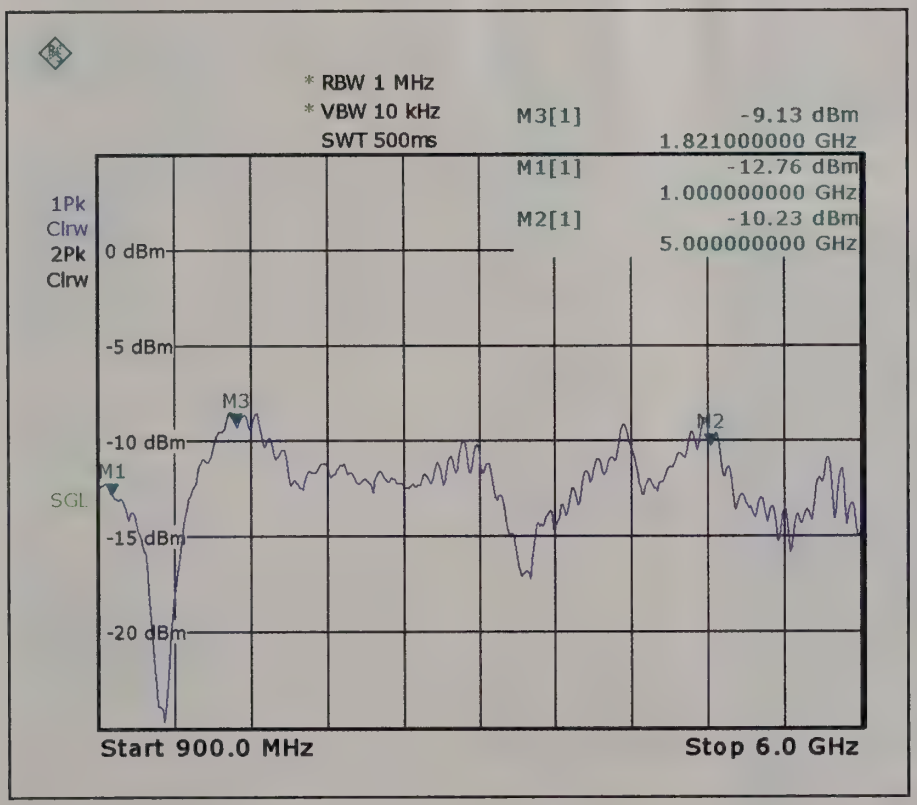

Figure 2. Return-loss plot of the homebrew Vivaldi antenna.

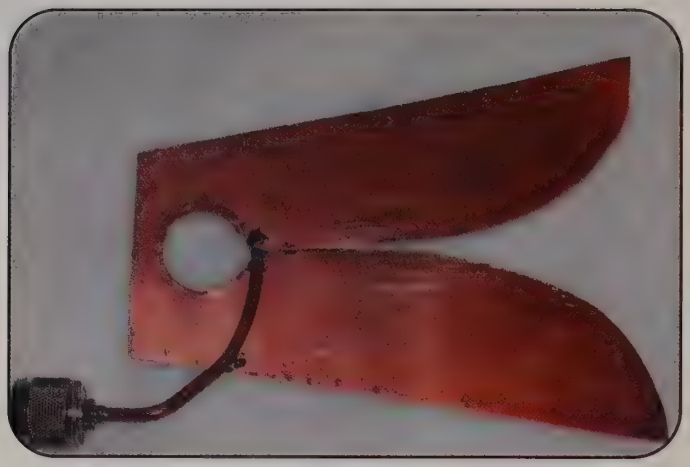

Photo E. The finished homebrew 1- to 6-GHz Vivaldi.

Photo F. Moving the feed point.

Photo G. Changing the high-frequency matching.

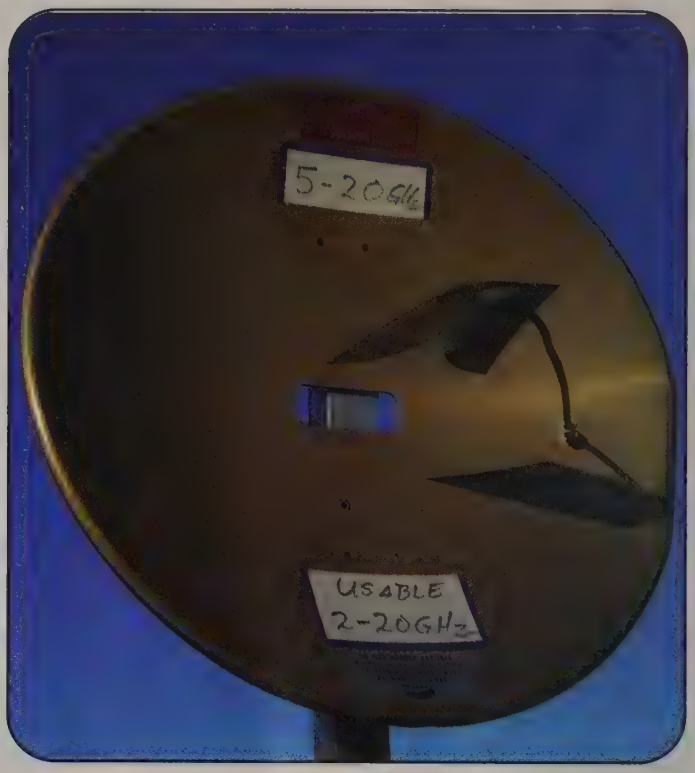

Photo H. Very broadband dish feed.

frequency counter or a spectrum analyzer. They also make a good broadband dish feed like the one in photo H. I recommend adjusting the focus for best gain at the highest frequency at which you plan to use the dish. The phase center of the antenna does move around with frequency, but if you optimize the feedpoint for the high end of the band, there is little phase error at the low end.

For the digital crowd, a 5- to 6-inch version can work as a 915 MHz, 2400 MHz, 3.4 GHz, 4.9 GHz, 5.2 GHz, and 5.8 GHz antenna or dish feed, all at the same time.

For AMSAT we are working on a circularly polarized version of the Vivaldis. Using two Vivaldis mounted in X fashion and fed with a special phase shifter, we just might be able to work up a 2- to 6-GHz circularly polarized dish feed for the next generation of AMSAT birds or a combined L-Band/S-Band dish feed.

Also, last time we talked about UWB, or Ultra Wide Band, signals in this column. Vivaldi's make great UWB antennas!

Next Time

I've run out of column room at this point and I have several more Vivaldi tricks to talk about, so next time we will talk more about improving the return loss/SWR at particular points in the band and how to add your own personal touches. Also, I'm sure other topics will pop up.

As always, we like your antenna questions and suggestions for column topics. Just drop me an e-mail at <wa5vjb@cq-vhf.com> or you can visit <www.wa5vjb.com> for other antenna projects or even Vivaldi antenna templates. You, our readers, provide some of the best topics for columns.

73, Kent, WA5VJB

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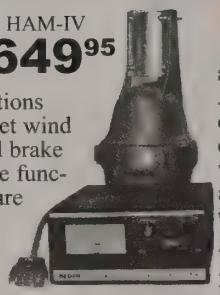

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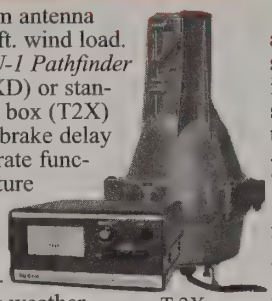
HAM IV and HAM V Rotator Specifications	
Wind Load capacity (inside tower)	15 square feet
Wind Load (w/mast adapter)	**7.5 square feet**
Turning Power	800 in.-lbs.
Brake Power	**5000 in.-lbs.**
Brake Construction	Electric Wedge
Bearing Assembly	**dual race/96 ball bearings**
Mounting Hardware	Clamp plate/steel U-bolts
Control Cable Conductors	**8**
Shipping Weight	26 lbs.
Effective Moment (in tower)	**2800 ft.-lbs.**

TAILTWISTER SERIES II



For large medium antenna arrays up to 20 sq. ft. wind load. Available with *DCU-1 Pathfinder* digital control (T2XD) or standard analog control box (T2X) with *new* 5-second brake delay and *new* Test/Calibrate function. Low temperature grease, alloy ring gear, indicator potentiometer, ferrite beads on potentiometer wires, *new* weatherproof AMP connectors plus 8-pin plug at control box, triple bearing race with 138 ball bearings for large load bearing strength, electric locking steel wedge brake, North or South center of rotation scale on meter, low voltage control, $2^{1}/_{16}$ inch max. mast.

T-2X
$799.95

T-2XD
$1229.95
with DCU-1

TAILTWISTER Rotator Specifications	
Wind load capacity (inside tower)	20 square feet
Wind Load (w/ mast adapter)	**10 square feet**
Turning Power	1000 in.-lbs.
Brake Power	**9000** in.-lbs.
Brake Construction	Electric Wedge
Bearing Assembly	**Triple race/138 ball brngs**
Mounting Hardware	Clamp plate/steel U-bolts
Control Cable Conductors	**8**
Shipping Weight	31 lbs.
Effective Moment (in tower)	**3400 ft.-lbs.**

CD-45II

CD-45II
$449.95

For antenna arrays up to 8.5 sq. feet mounted inside tower or 5 sq. ft. with mast adapter. Low temperature grease good to -30 F degrees. *New* Test/Calibrate function. Bell rotator design gives total weather protection, dual 58 ball bearing race gives proven support. Die-cast ring gear, stamped steel gear drive, heavy duty, trouble free gear train, North center scale, lighted directional indicator, 8-pin plug/socket on control unit, snap-action control switches, low voltage control, safe operation, takes maximum mast size to $2^{1}/_{16}$ inches. MSLD light duty lower mast support included.

CD-45II Rotator Specifications	
Wind load capacity (inside tower)	8.5 square feet
Wind Load (w/ mast adapter)	**5.0 square feet**
Turning Power	600 in.-lbs.
Brake Power	**800 in.-lbs.**
Brake Construction	Disc Brake
Bearing Assembly	**Dual race/48 ball brings**
Mounting Hardware	Clamp plate/steel U-bolts
Control Cable Conductors	**8**
Shipping Weight	22 lbs.
Effective Moment (in tower)	**1200 ft.-lbs.**

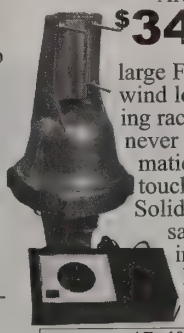
HAM-V

HAM-V
$1099.95
with DCU-1

For medium antenna arrays up to 15 square feet wind load area. Similar to the HAM IV, but includes *DCU-1 Pathfinder* digital control unit with gas plasma display. Provides automatic operation of brake and rotor, compatible with many logging/contest programs, 6 presets for beam headings, 1 degree accuracy, auto 8-second brake delay, 360 degree choice for center location, *more!*

AR-40

AR-40
$349.95

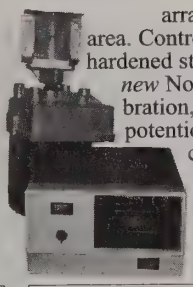


For compact antenna arrays and large FM/TV up to 3.0 square feet wind load area. Dual 12 ball bearing race. Automatic position sensor never needs resetting. Fully automatic control -- just dial and touch for any desired location. Solid state, low voltage control, safe and silent operation. $2^{1}/_{16}$ inch maximum mast size. MSLD light duty lower mast support included.

AR-40 Rotator Specifications	
Wind load capacity (inside tower)	3.0 square feet
Wind Load (w/ mast adapter)	**1.5 square feet**
Turning Power	350 in.-lbs.
Brake Power	**450 in.-lbs.**
Brake Construction	Disc Brake
Bearing Assembly	**Dual race/12 ball bearings**
Mounting Hardware	Clamp plate/steel bolts
Control Cable Conductors	**5**
Shipping Weight	14 lbs.
Effective Moment (in tower)	**300 ft.-lbs.**

HDR-300A

HDR-300A
$1499.95



For ***king-sized*** antenna arrays up to 25 sq.ft. wind load area. Control cable connector, *new* hardened stainless steel output shaft, *new* North or South centered calibration, *new* ferrite beads on potentiometer wires reduce RF susceptibility, *new* longer output shaft keyway adds reliability. Heavy-duty self-centering steel clamp and hardware. Display accurate to 1°. Machined steel output.

HDR-300A Rotator Specifications	
Wind load capacity (inside tower)	25 square feet
Wind Load (w/ mast adapter)	**not applicable**
Turning Power	5000 in.-lbs.
Brake Power	**7500 in.-lbs.**
Brake Construction	solenoid operated locking
Bearing Assembly	**bronze sleeve w/rollers**
Mounting Hardware	stainless steel bolts
Control Cable Conductors	**7**
Shipping Weight	61 lbs.
Effective Moment (in tower)	**5000 ft.-lbs.**

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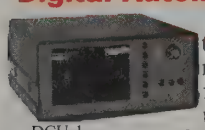
MSLD, $39.95. Light duty mast support for CD-45II and AR-40.
TSP-1, $34.95. Lower spacer plate for HAM-IV and HAM-V.

Digital Automatic Controller



DCU-1
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Automatically controls T2X, HAM-IV, V rotators. 6 presets for favorite headings, 1° accuracy, 8-sec. brake delay, choice for center of rotation, crisp *plasma* display. Computer controlled with many logging/contest programs.

AR-35 Rotator/Controller

AR-35
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For UHF, VHF, 6-Meter, TV/FM antennas. Includes automatic controller, rotator, mounting clamps, mounting hardware. 110 VAC. One Year Warranty.

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Provides automatic 5-second brake delay -- insures your rotator is fully stopped before brake is engaged. Prevents accidentally engaging brake while rotator is moving. Use with HAM II, III, IV, V, T2Xs. Easy-to-install. Includes pre-assembled PCB, hardware.

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By Tomas Hood,* NW7US

VHF PROPAGATION

The Science of Predicting VHF-and-Above Radio Conditions

Old and New Science

During solar Cycle 23's approximately eleven years, scientists have worked with increased passion and resources to discover everything possible about the Sun, space weather, and geophysical and ionospheric phenomena. They've been busy launching many new satellites and other research spacecraft, building new models to better fit the resulting data, and discovering many new and revealing facts in the mix of all of the rich and new data.

One amazing discovery involves the magnetic connection between our Sun and Earth. The reigning model described a process whereby solar material (charged solar matter) may enter into our atmosphere, triggering aurora and creating geomagnetic disturbances. Conventional understanding of the process required the magnetic orientation of the magnetic field lines of the solar wind to be oriented "southward" in relationship to Earth's magnetosphere before solar material could effectively enter through a "hole" in the resulting reconnection of the two magnetic-field structures. As the two fields became aligned in this way, it is called "reconnection." When a reconnection occurs, it allows material on the solar wind to "ride" the field lines down toward Earth's northern and southern magnetic poles. If the orientation is "northward," then this reconnection between the Sun's and Earth's magnetic fields would not occur, and solar material would be deflected around the Earth by the magnetosphere. As a result, the magnetosphere is stretched far out into space away from the sun (see figure 1). The new discovery radically alters this model.

During February 2007 NASA launched five spacecraft for the primary goal of exploring macroscale interactions during ionospheric and geomagnetic substorms. This project is called THEMIS, the acronym for Time History of Events and Macroscale Interactions during Substorms, and it is the fifth medium-class mission under NASA's Explorer Program. The University of California, Berkeley's Space Sciences Laboratory managed the project development and is currently operating the THEMIS mission. Swales Aerospace, Beltsville, Maryland, built the THEMIS satellites.

Scientists, using THEMIS, discovered a breach in Earth's magnetic field ten times larger than anything previously thought to exist. However, the breach itself is not the biggest surprise. Researchers are even more amazed at the strange and unexpected way it forms, overturning long-held ideas of space physics.

"At first I didn't believe it," says THEMIS project scientist David Sibeck

*P.O. Box 9, Stevensville, MT 59870
e-mail: <nw7us@arrl.net>

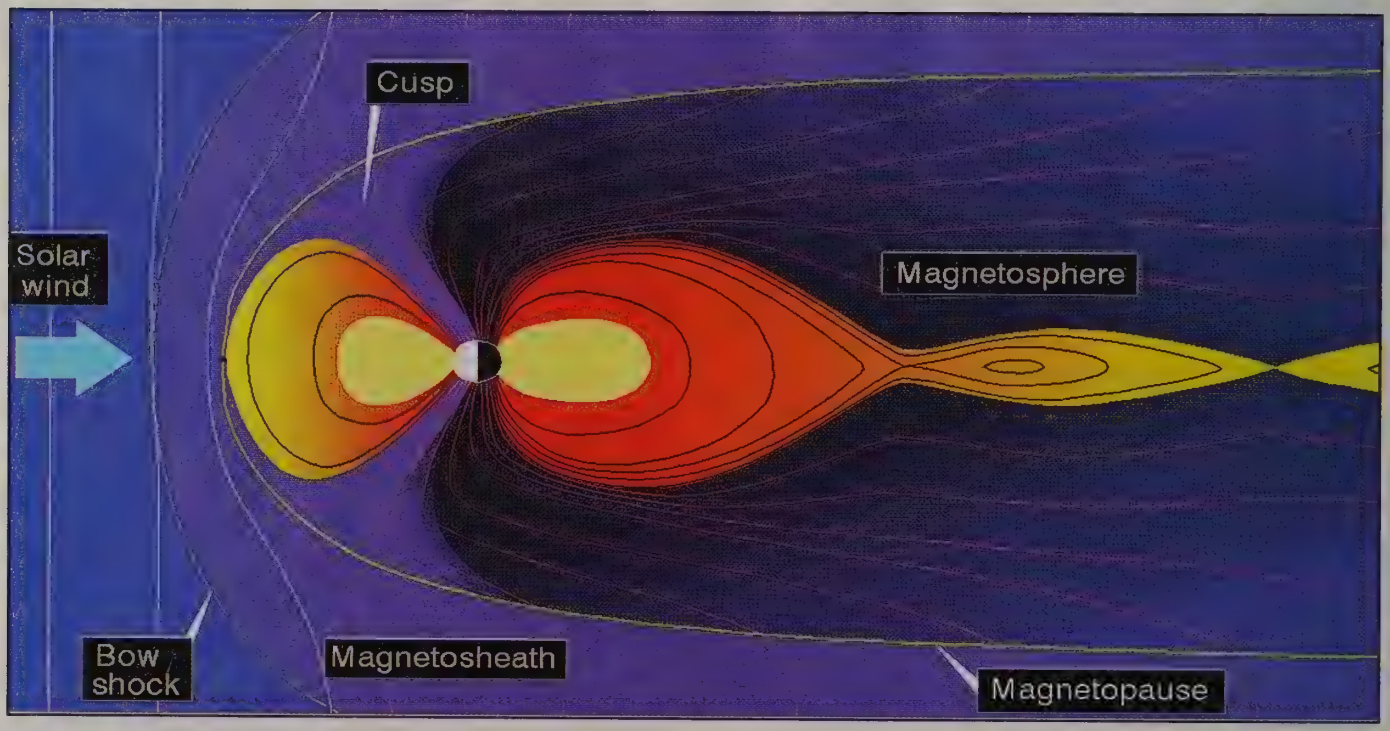

Figure 1. Earth's magnetic field gets stretched out into a comet-like shape with a tail of magnetism that stretches millions of miles behind Earth, opposite from the Sun. The Sun has a wind of gas that pushes Earth's field from the left to the right in this drawing. (Credit: NASA)

of the Goddard Space Flight Center. "This finding fundamentally alters our understanding of the solar-wind–magnetosphere interaction."

The big discovery came on June 3, 2007, when the five probes serendipitously flew through the breach just as it was opening. Onboard sensors recorded a torrent of solar-wind particles streaming into the magnetosphere, signaling an event of unexpected size and importance.

"The opening was huge—four times wider than Earth itself," says Wenhui Li, a space physicist at the University of New Hampshire who has been analyzing the data. Li's colleague Jimmy Raeder, also of New Hampshire, says, "10^{27} particles per second were flowing into the magnetosphere—that's a 1 followed by 27 zeroes. This kind of influx is an order of magnitude greater than what we thought was possible."

There was little warning that this event was about to happen. A complex bundle of magnetic fields from the Sun, along with a "cloud" of solar material, rode the solar wind and wrapped itself around the magnetosphere and "cracked" it open. The cracking was accomplished by means of magnetic reconnection. Magnetic conduits over the Arctic and Antarctic quickly expanded; within minutes they overlapped over Earth's equator to create the biggest magnetic breach ever recorded by Earth-orbiting spacecraft (see figure 2).

The size of the breach took researchers by surprise. "We've seen things like this before," says Raeder, "but never on such a large scale. The entire day-side of the magnetosphere was open to the solar wind." (See figure 3.)

The circumstances were even more surprising. Space physicists have long believed that holes in Earth's magnetosphere open only in response to solar magnetic fields that point south. The great breach of June 2007, however, opened in response to a solar magnetic field that pointed north.

When the solar-wind magnetic fields are oriented northward, it is referred to as a "positive IMF," for a positive Interplanetary Magnetic Field index. A southerly-oriented IMF is a negative index. This data is reported as the "B sub Z (B_z) index."

The solar wind bombards the Earth's magnetosphere almost directly above the sunlit equator where Earth's magnetic field points north. If a cloud of solar plasma arrives on the solar wind with a northwardly-oriented magnetic field, the two fields should reinforce one another, strengthening Earth's magnetic defenses and slamming the door shut on the solar wind.

"So, you can imagine our surprise when a northern IMF came along and shields went down instead," says Sibeck. "This completely overturns our understanding of things."

This finding reveals that northern IMF events, while not actually triggering geomagnetic storms, create favorable conditions for these storms by loading the magnetosphere with plasma. A loaded magnetosphere is primed for auroras, power outages, and other disturbances that can result when, say, a CME (coronal mass ejection) hits.

The years ahead could be especially lively. Raeder explains: "We're entering solar Cycle 24. For reasons not fully understood, CMEs in even-numbered solar cycles (such as 24) tend to hit Earth with a leading edge that is magnetized north. Such a CME should open a breach and load the magnetosphere with plasma just before the storm gets under way. It's the perfect sequence for a really big event."

Sibeck agrees: "This could result in stronger geomagnetic storms than we have seen in many years."

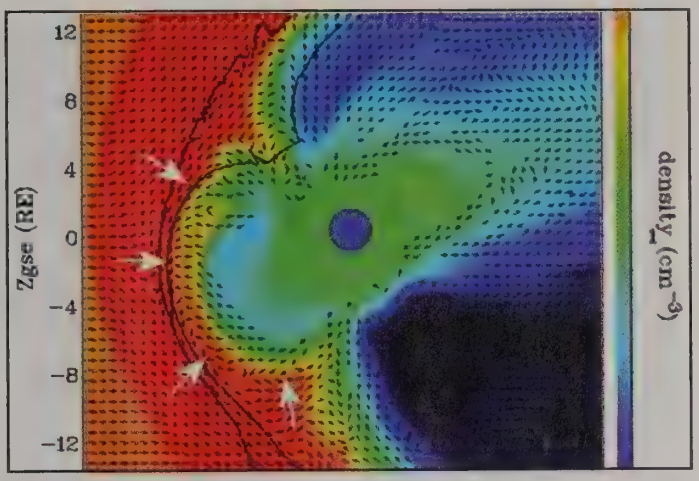

Figure 2. A computer model of solar wind flowing around Earth's magnetic field on June 3, 2007. Background colors represent solar-wind density; red is high density; blue is low. Solid black lines trace the outer boundaries of Earth's magnetic field. Note the layer of relatively dense material beneath the tips of the white arrows; that is solar wind entering Earth's magnetic field through the breach. (Credit: Jimmy Raeder/UNH [University of New Hampshire])

That's great news for the VHF weak-signal enthusiasts, since this can result in many strong aurora-mode propagation openings during this new solar cycle.

In the next issue, we'll look at more of the "new" science coming out of the current research from THEMIS and other space weather projects.

Propagation Outlook for February through April

Because of the nature of the Earth's orbit around our Sun, we have two seasons each year when any adverse space weather has a greater influence on causing geomagnetic disturbances: The first is known as the Spring Equinoctial season, and the second is known as the Autumnal Equinoctial season. These are the two times during the course of the Earth's orbit around the Sun when the Earth is in just the right position to be most influenced by solar activity.

The Spring Equinoctial season peaks between March and April of each year. Because we're in the very start of solar Cycle 24, it is likely that we will have significant geomagnetic disturbances this year, triggering the sort of auroral activity known to bring about VHF activity.

What is the Aurora?

Aurora is a direct result of solar plasma interacting with gasses in the upper atmosphere. Aurora occurs during geomagnetic substorms. During these substorms, solar-wind plasma resulting from coronal mass ejections can rain down into the atmosphere. Gasses in the atmosphere start to glow under the impact of these particles. Different gasses give out various colors. Think of a neon sign and how the plasma inside the glass tube, when excited, glows with a bright color. These precipitating particles mostly follow the magnetic-field lines that run from Earth's magnetic poles and are concentrated in circular regions around the magnetic poles called "auroral ovals." These

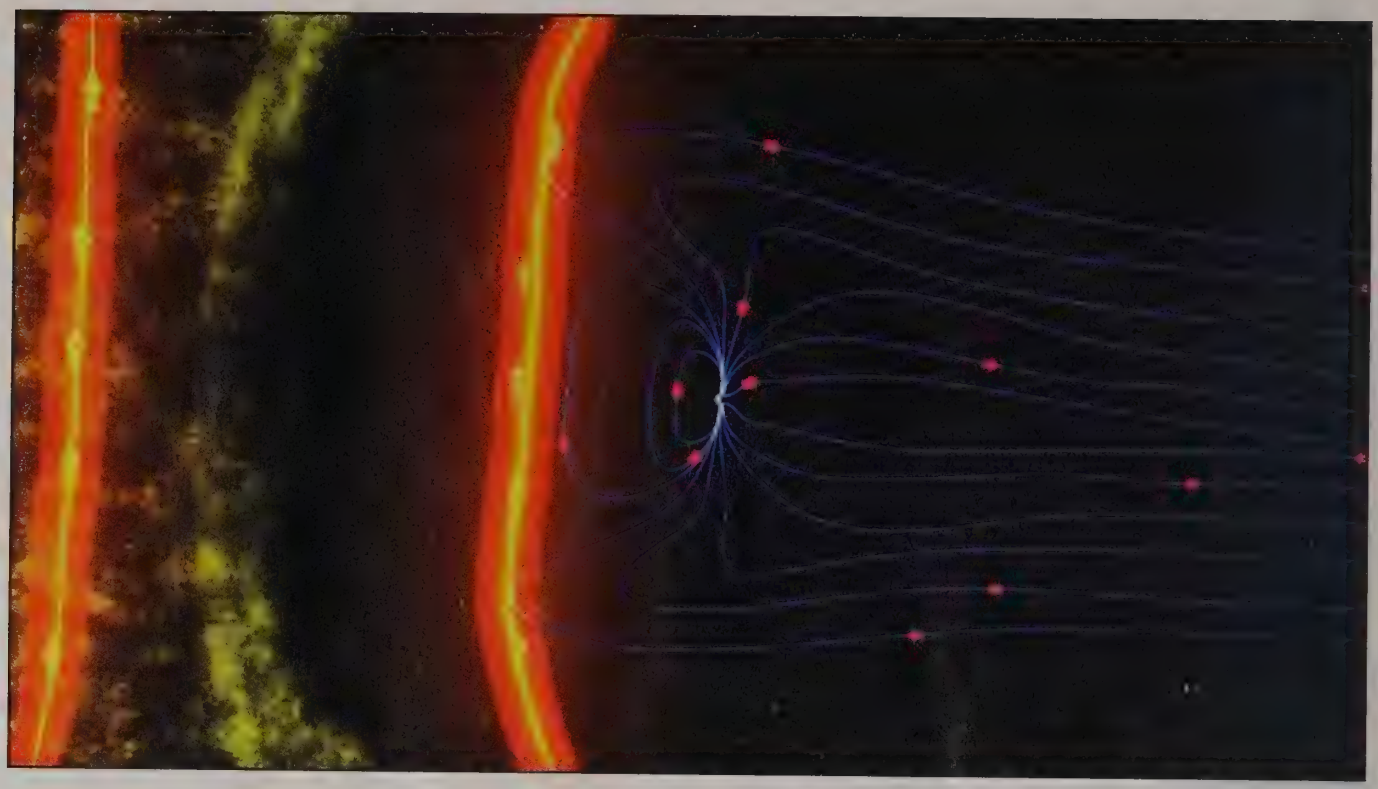

Figure 3. Earth's magnetic field, which shields our planet from severe space weather, often develops two holes that allow the largest leaks of the solar particles. (Credit: NASA/Goddard Space Flight Center)

bands expand away from the poles during magnetic storms. The stronger the storm, the greater these ovals will expand. Sometimes they grow so large that people at middle latitudes, such as California, can see these "Northern Lights."

Because the Earth's magnetic dipole axis is most closely aligned with the Sun's solar-wind spiral in April and October, the interaction between the solar wind and the Earth's magnetosphere is greatest during these two seasons. This is why aurora is most likely to occur and strongest during the equinoctial months. When you see the solar-wind speed increase to over 500 kilometers per second, and the Bz remains mostly negative (the IMF is oriented mostly southward), expect an increase in geomagnetic activity, as revealed by the planetary *K*-index (*Kp*).

This year, the Spring Equinoctial season will be active, with a few strong geomagnetic storms. If we do experience moderate to storm-level activity due to recurring coronal holes, look for aurora-mode propagation. The higher the *Kp*, the more likely you may see the visual aurora. However, you don't have to see them to hear their influence on propagation. Listen for stations from over the poles that sound raspy or fluttery. Look for VHF DX. Sometimes it will enhance a path at certain frequencies, while other times it will degrade the signals. Sometimes signals will fade quickly and then come back with great strength. The reason for this is that the radio signal is being refracted off the more highly ionized areas in the *E* region of the ionosphere that are energized by this aurora. These ionized areas ebb and flow, so the ability to refract changes, sometimes quickly. I've observed the effect of aurora and associated geomagnetic storminess even on lower HF frequencies.

Radio Aurora

If there are enough solar particles flowing down the Earth's magnetic-field lines and colliding with atmospheric atoms and molecules, ionization occurs. This ionization may be sufficient to reflect VHF and lower UHF radio waves, generally between 25 and 500 MHz. This usually occurs in conjunction with visual aurora, but the mechanism is a bit different and it is possible to have one (visual or radio) without the other.

Using radio aurora, the chances of contacting stations over greater distances than would ordinarily be possible on the VHF frequencies is increased. Like its visual counterpart, radio aurora is very unpredictable. The thrill of the chase draws many VHF weak-signal DXers to work auroral DX.

VHF auroral echoes, or reflections, are most effective when the angle of incidence of the signal from the transmitter, with the geomagnetic field line, equals the angle of reflection from the field line to the receiver. Radio aurora is observed almost exclusively in a sector centered on magnetic north. The strength of signals reflected from the aurora is dependent on the wavelength when equivalent power levels are employed. Six-meter reflections can be expected to be much stronger than 2-meter reflections for the same transmitter output power. The polarization of the reflected signals is nearly the same as that of the transmitted signal.

The *K*-index is a good indicator of the expansion of the auroral oval, and the possible intensity of the aurora. When the *K*-index is higher than 5, most operators in the northern states and in Canada can expect favorable aurora conditions. If the *K*-index reaches 8 or 9, it is highly possible for radio aurora to be worked by stations as far south as California and

Florida. Your magnetic latitude can be found using the map at <http://www.sec.noaa.gov/Aurora/globeNW.html>.

Meteors

While there are no major meteor showers during February and March, April has a few meteor showers worthy of note. These are the *Lyrids*, the *Puppids*, and *Aquarids*.

The *Lyrids* peak on April 22 at 1100 UTC. While this shower peaks at about 18 meteors per hour, or about one per every five minutes on average, it can provide some good radio bursts. It is possible to see the hourly meteor rate (ZHR) reach as high as 90 per hour. The debris expelled by comet Thatcher as it moves through its orbit causes the *Lyrids*. It is a long-period comet that visits the inner solar system every 415 years or so. Despite this long period, there is activity every year at this time, so it is theorized that the comet must have been visiting the solar system for quite a long time. Over this long period, the debris left with each pass into the inner solar system has been pretty evenly distributed along the path of its orbit. This material isn't quite evenly distributed however, as there have been some years with outbursts of higher than usual meteor activity. The most recent of these outbursts occurred in 1982, with others occurring in 1803, 1922, and 1945. These outbursts are unpredictable and one could even occur this year. The best time to work this shower should be from midnight to early morning.

The *Puppids* shower is another minor event and is best observed south of the equator. The rate can be around 40 per hour, but this may not play out this year. The peak occurs April 23 at 1600 UTC.

The *Aquarids,* however, while more prominent from tropical regions, can be a rich shower this year. The peak is in May, but the shower starts around April 19. The rate can be between 40 and 85 per hour. This year expectations are for the periodic peak, so this could be a player for meteor-scatter propagation.

The Solar Cycle Pulse

The observed sunspot numbers from September through November 2008 are 1.1, 2.9, and 4.1, showing a slow yet steady rise in the activity of the new sunspot cycle, Cycle 24. The smoothed sunspot counts for March through May 2008 are 3.3, 3.3, and 3.5. The smoothed numbers will likely show little improvement until the average covers the very last months of 2008.

The monthly 10.7-cm (preliminary) numbers from September through November 2008 are 67.1, 68.3, and 68.6. The smoothed 10.7-cm radio flux numbers for March through May 2008 are 69.5, 69.6, and 69.7. As with the smoothed sunspot numbers, the smoothed flux numbers will show little improvement until they include the last months of 2008.

The smoothed planetary *A*-index (*Ap*) numbers from March through May 2008 are 7.4, 7.1, and 6.9. The monthly readings from September through November 2008 are 5, 6, and 3. It has been noted that the overall geomagnetic condition has been much quieter during the minimum period between solar Cycles 23 and 24 than the last few prior solar cycle minimums.

The monthly sunspot numbers forecast for February through April 2009 are 18, 21, and 25. That's really great news, as we'll likely see improvement in *F*-layer propagation higher and higher in the radio spectrum. The monthly 10.7-cm radio flux is predicted to be 74, 77, and 79 for the same period. *(Note that these are preliminary figures. Solar scientists make minor adjustments after publishing, by careful review.)*

Feedback, Comments, Observations Solicited!

I am looking forward to hearing from you about your observations of VHF and UHF propagation. Please send your reports to me via e-mail, or drop me a letter about your VHF/UHF experiences (sporadic-*E*, meteor scatter?). I'll create summaries and share them with the readership. I look forward to hearing from you.

You are also welcome to share your reports at my public forums at <http://hfradio.org/forums/>. Up-to-date propagation information is found at my propagation center, at <http://prop.hfradio.org/> and via cell phone at <http://wap.hfradio.org/>.

Until the next issue, happy weak-signal DXing.

73 de Tomas, NW7US

By Bob Witte,* KØNR

FM/Repeaters—Inside Amateur Radio's "Utility" Mode

A Look Inside D-STAR Modulation

For the Winter 2006 issue of *CQ VHF*, I provided an overview of D-STAR radio technology. At that time, the technology was just starting to emerge onto the amateur radio scene, and the amateur radio community was just starting to understand how the technology worked. By now there are quite a few D-STAR repeaters on the air, and many radio amateurs have experienced D-STAR communications on the VHF and UHF bands.

As D-STAR enthusiasts have gotten their hands on the hardware, they have been experimenting with the various features. In typical ham fashion, the techies are reverse engineering and tinkering with the ICOM D-STAR equipment and in some cases even creating their own D-STAR designs.

Block Diagram

In this column we'll examine the modulation scheme used in D-STAR, focusing on the signal-processing chain from the microphone to the modulator (figure 1). For digital modulation, we need to get the microphone audio into digital form and properly modulated onto the carrier, similar to analog modulation. In Figure 1, we see that the microphone audio is boosted by an amplifier to a suitable level for driving an *analog-to-digital (A/D) converter*. The A/D converter samples the microphone audio and converts it into a series of digital numbers that represent the microphone waveform. The digitized audio is fed into the *vocoder*, which processes the waveform, still in digital form, to reduce the number of bits per second needed to represent the voice waveform. The vocoder drives the digital modulator circuit, which for D-STAR is a *GMSK (Gaussian Minimum Shift Keying)* modulator (more on that later). At the output of the GMSK modulator, we see the modulated GMSK signal, which drives the RF transmitter chain.

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GMSK

Before we dive into the topic of GMSK, we first need to review some other forms of digital modulation. One basic form of digital modulation is Frequency Shift Keying, or FSK. Radio amateurs have used FSK for decades, including using it to send radio teletype signals (RTTY) on the HF bands. The concept is simple: When the digital signal is a logical zero one frequency is output, and when the digital signal is a logical one a different frequency is output. The receiver on the other end has a demodulator circuit that detects the two frequencies and outputs the recovered digital signal accordingly.

A special type of FSK that is a little more efficient in terms of bandwidth is called Minimum Shift Keying (MSK). MSK uses a frequency shift that maintains a specific relationship between the frequency of a logical zero and the frequency of a logical one: *The difference between the two frequencies is one half of the bit rate.*

Mathematically, this can be expressed in terms of the *modulation index*:

$$m = \Delta f \times T$$

where:
$\Delta f = |f_1 - f_0|$
T = period of one bit

For MSK, the modulation index is 0.5.

Figure 2 shows this graphically, with a logical one creating a sine wave that just fits into one bit period. In this example, a logical zero has a higher frequency that fits *one-and-a-half cycles* into the bit period. Notice that the phases of the sine waves are controlled to prevent any phase discontinuities. Any discontinuities in the waveform result in a wider signal bandwidth, something that we want to avoid.

Conceptually, MSK can be created by driving an FM modulator with the digital signal, while maintaining a modulation index of 0.5. (The practical circuit implementation is likely to be more complicated than this, but we'll ignore that detail in this article.) The sharp edges of the digital input will tend to create a wide-bandwidth signal, so a shaping filter is often used to round out the waveform. When a *Gaussian filter* is used, the modulation is called *Gaussian Minimum Shift Keying*, or GMSK (figure 3).

Many different modulation formats have been developed for modern digital communications systems, each with their

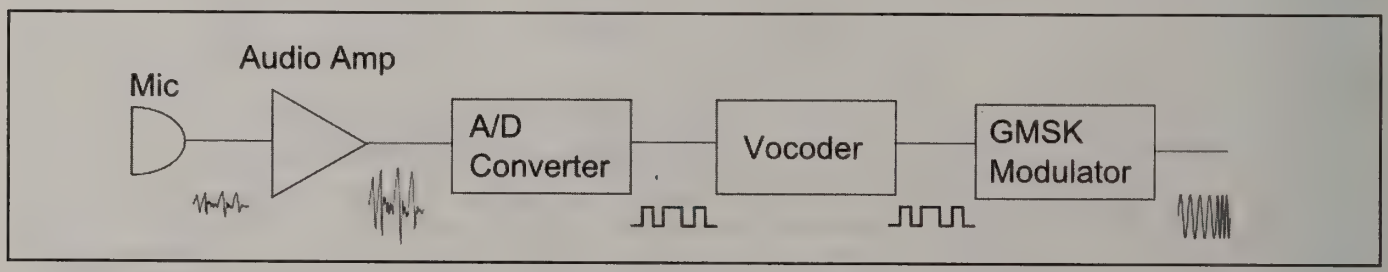

Figure 1. The simplified block diagram of a D-STAR modulation system.

own advantages and disadvantages. GMSK has some attractive properties that make it a good choice for mobile radio, including D-STAR. Compared to other digital modulation schemes, GMSK is relatively simple, resulting in a lower system cost. GMSK signals have constant amplitude, which means that GMSK is insensitive to amplifier nonlinearities. Higher efficiency Class-C amplifiers can be used to boost the signal without degrading the modulation format. (This is not true of some other digital modulation techniques.) GMSK also has good spectral efficiency, which is to say it packs a large chunk of digital information into a small bandwidth. The most common digital cell-phone format in use today (GSM) also uses GMSK.

It turns out that GMSK has quite a bit in common with good old analog FM. Both modulation formats produce a constant-amplitude signal, which makes them less susceptible to amplitude variations, including noise. All of the modulating information exists in the form of frequency/phase, and they both can use Class-C amplification.

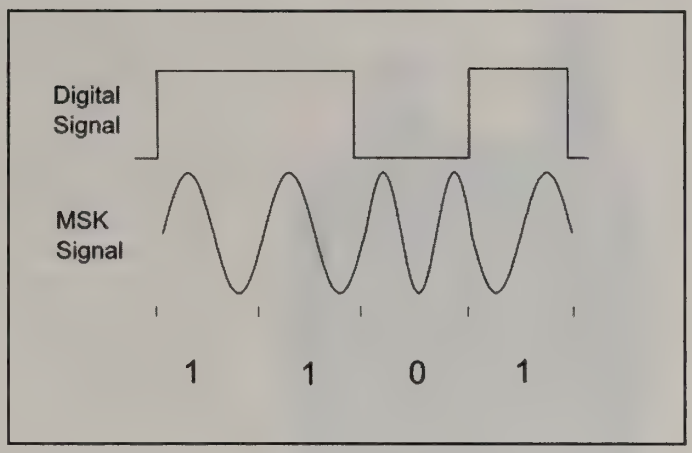

Figure 2. Example waveforms for MSK modulation, with a digital input signal and the resulting MSK signal.

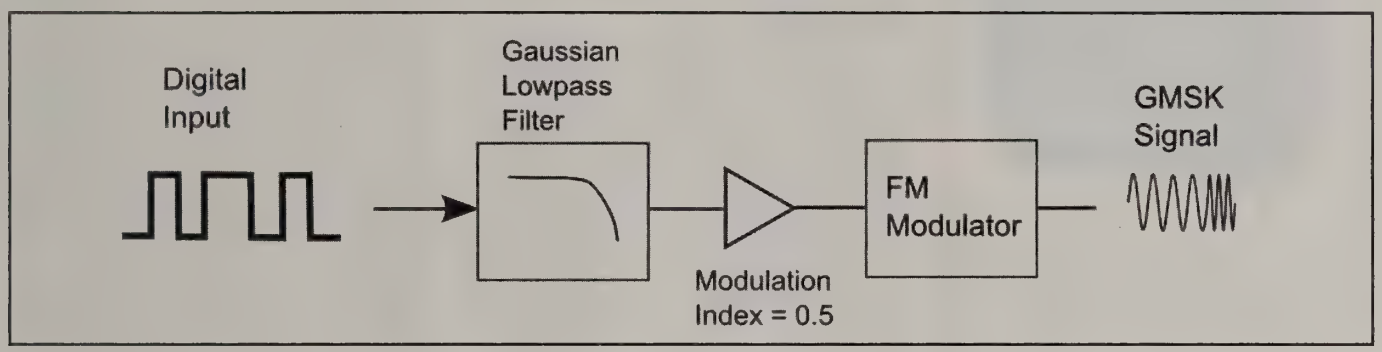

Figure 3. Simplified block diagram of the GMSK modulator.

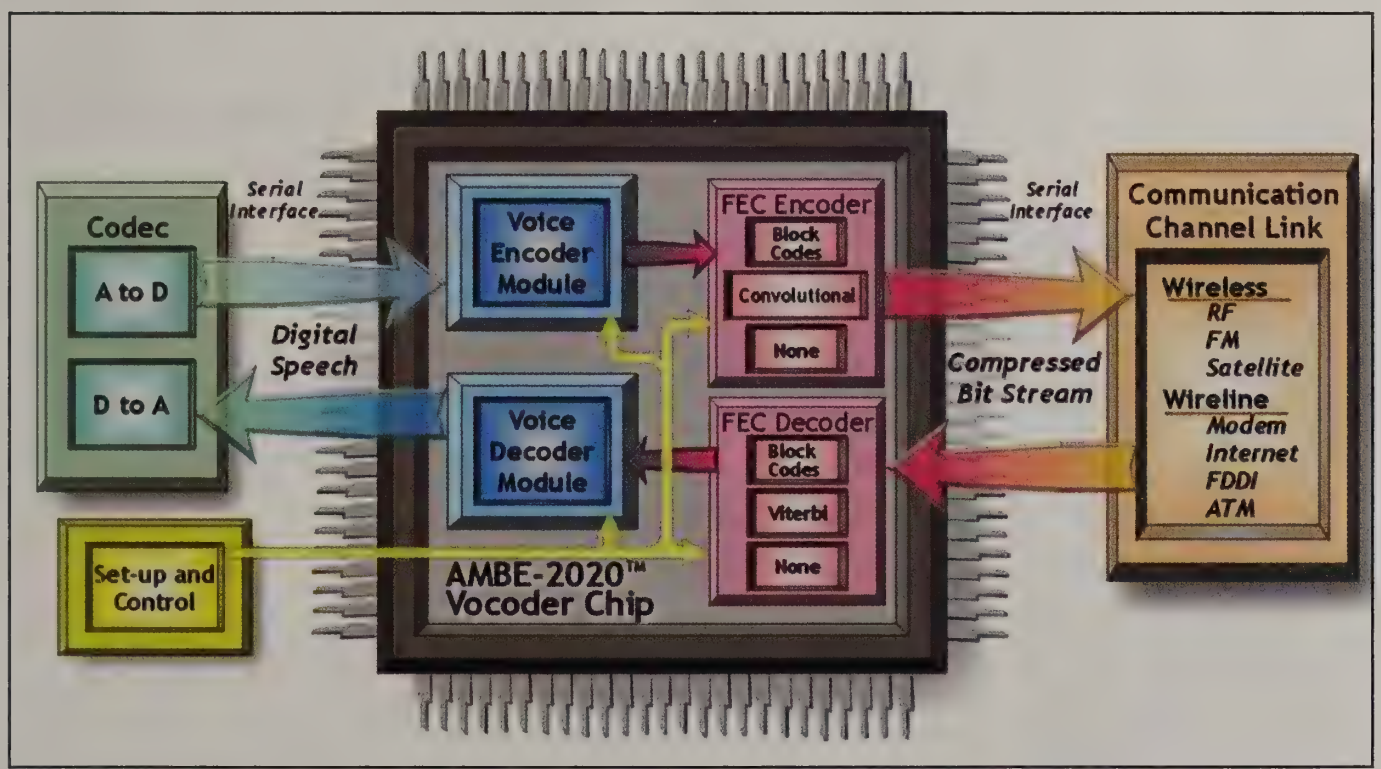

Figure 4. Block diagram of the AMBE-2020™ Vocoder. (Courtesy of DVSI, used with permission)

Figure 5. The IC-91AD is a dualband D-STAR handheld transceiver from ICOM. (Photo courtesy of rigpix.com)

One might be tempted to think that GMSK signals could pass through a conventional FM repeater, but in most cases this is unlikely. Conventional repeaters are set up for analog signals, rolling off the low-frequency response as they pass through the repeater, which distorts the D-STAR waveform. Some hams have been successful tweaking the frequency response of their repeater receiver-to-transmitter path for the express purposes of passing D-STAR signals, but your normal FM repeater will mostly likely not pass D-STAR. (The repeater may key up if carrier access is in use.) Just to be clear, D-STAR signals *cannot* be demodulated by conventional FM radios. D-STAR sounds like white noise on an FM receiver.

Vocoder

The previous discussion describes how digital bits get modulated onto the RF signal, but we also need to pay attention to the number of bits per second we feed into the GMSK modulator. This has been one of the major challenges of radio communications using digital modulation—to keep the bit rate low enough to travel down a narrowband channel while still maintaining voice quality. The nominal bandwidth for the DV form of D-STAR is 6 kHz wide and the A/D converter samples at 8 kHz. It is the job of the vocoder to cram 8 kHz worth of samples into this 6-kHz bandwidth. The vocoder takes the digitized analog signal and compresses it into the minimum number of bits required to keep it intelligible.

D-STAR uses the AMBE-2020™ Vocoder from Digital Voice Systems, Inc (DVSI); see figure 4. This vocoder uses a proprietary algorithm (Advanced Multi-Band Excitation, or AMBE®) to convert the 8-kHz sampled audio into a 3600-bps bit stream for D-STAR voice. This stream is combined with the 1200-bps data stream to produce the combined voice + data DV signal at 4800 bps. (We won't go into much detail here about the 1200-bps data stream other than to say that it can support a low-speed data connection simultaneously with the digital voice transmission.) In general, vocoders use the characteristics of human speech to create advanced compression algorithms to produce an intelligible and recognizable voice signal at the other end of the channel.

Like all vocoders, the AMBE-2020 has a noticeable "digital" sound to it, similar

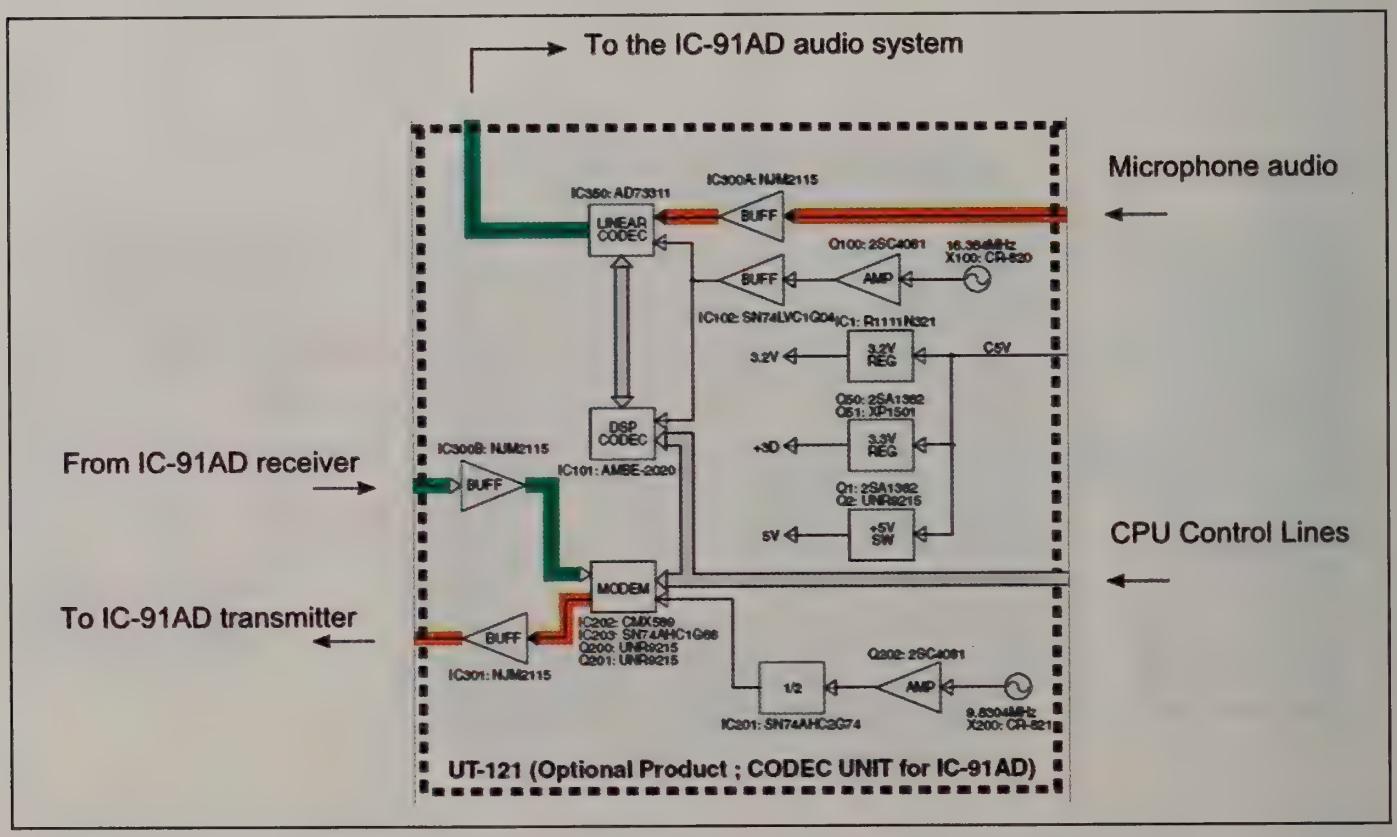

Figure 6. Block diagram of the UT-121, the D-STAR board used in the ICOM IC-91AD. (Copyright ICOM, used with permission)

to a typical digital mobile phone. To my ear, the sound quality is plenty good enough, although I agree that it doesn't sound quite as good as analog FM. These are *not* high-fidelity coding systems and are not very effective at handling anything but speech signals. Vocoders usually include special modes for capturing common signaling tones such as DTMF signals. The Utah VHF Society recently published some test results from transmitting non-voice signals over D-STAR, in an attempt to educate the amateur radio community about the characteristics of vocoders. (See the Utah VHF Society website listed in the References box.)

The AMBE-2020 implements *Forward Error Correction (FEC)*, which inserts redundant bits into the data stream so that errors introduced in the channel can be corrected. This is a common technique used in digital communications that allows the communication system to tolerate and correct low levels of errors in the digital transmission. Low levels of Bit Error Rate (BER) can cause a slight twang in the vocoder algorithm, but as the Bit Error Rate (BER) increases, the FEC will struggle to compensate, eventually falling apart. This gives us the experience of "going digital" when the audio breaks into a wacky, digitally-distorted noise.

Some hams have criticized the use of a proprietary vocoder in an amateur radio system. They argue that the spirit of amateur radio is experimentation and the choice of this vocoder gets in the way of that objective. For example, it would be really useful to implement the AMBE algorithm in software so that it can be deployed on a PC. Since the algorithm is protected by DVSI patents, the only legal choice is to buy the chip from DVSI. Some people have claimed that the chip is unaffordable, but they are available for approximately $20 each, a reasonable price for an IC of this complexity.

Typical D-STAR Design

Let's take a look a typical D-STAR design, the ICOM UT-121, which is the D-STAR board used in the IC-91AD (figure 5). (This board is also the option that adds D-STAR to the IC-91A transceiver.) The block diagram of the UT-121 is shown in figure 6. At the top of the diagram, we have the Analog Devices AD73311, labeled "Linear Codec," which is a general-purpose mixed-signal interface circuit. It contains the A/D converter used to digitize the microphone audio, and the D/A converter for converting the received bits back into analog form to drive the speaker. Our discussion of figure 1 was about the transmitter path only, but there is an equivalent signal-processing chain that operates in the opposite direction—decoding the GMSK signal and extracting the original transmitted analog voice signal. The UT-121 has both of these signal-processing chains, with the major chips supplying functionality for both transmit and receive.

Near the left center of the diagram we see the "DSP Codec," which is the AMBE-2020 vocoder. The digitized audio from the AD73311 is fed to the vocoder to be digitally compressed and passed along to the GMSK modem chip below. The AMBE-2020 also decompresses the received bit stream and passes it along to the AD73311 to be converted back to analog form. The GMSK modem chip, the CMX589, is labeled "Modem" in figure 6. This chip provides the GMSK transmit modulation and receive demodulation functions and interfaces to the RF sections of the transceiver. The other circuits shown in figure 6 are system clocks and power supplies required to support the ICs on the D-STAR board.

Summary

This article provides a basic look at the modulation scheme used by D-STAR and the key circuits that make it work. My thanks goes to the many hams who are experimenting with the D-STAR mode and sharing their knowledge. One gathering point for these hams is the dstar_digital Yahoo! Group.

Thanks for taking the time to read another one of my columns on the *Utility Mode*. I always enjoy hearing from readers, so stop by my blog at <http://www.k0nr.com/blog> or send me an e-mail.

73, Bob KØNR

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By Rich Arland,* K7SZ

BEGINNER'S GUIDE

All you need to know but were afraid to ask . . .

An Exciting Time in Amateur Radio

The Basics of 2 meters and the FM Mode

Welcome to the new "Beginner's Guide" column in *CQ VHF*. My name is Rich Arland, callsign K7SZ, and I have been playing this ham radio game for over 45 years. However, that doesn't mean I know everything! As a matter of fact, there isn't a day that goes by when I don't learn something new about radio, the hobby, and/or computers and IT technology.

What an exciting time to be a radio amateur! Technology is growing exponentially and our hobby is changing daily. The days of stringing up an end-fed wire and working CW contacts has been enhanced by the technological explosion associated with our hobby. Don't get me wrong, as I have had (and continue to have) a lot of fun on the HF bands using QRP (less than 5 watts output power) and simple antennas to work some fantastic DX. However, there is real excitement on the VHF/UHF bands and the associated "magic black boxes" that have opened a vast new world of communications that could only have been dreamed about a brief 10–15 years ago. Back in the late 1960s and early '70s, how many of us could have envisioned *Star Trek* type "communicators" that look very much like our present-day cell phones? Ditto with our PCs and wireless networks that literally are everywhere! Technology is the name of the game in today's radio hobby.

Technology can be formidable and quite intimidating, especially for a newcomer to our hobby. It can also be quite a challenge for us old timers, who grew up on vacuum-tube theory and power supplies that could kill you! My job, as editor of this column, is to help radio amateurs who are just starting out in the hobby or transitioning from HF to the VHF/UHF bands better understand the current trends and technologies that make the VHF+ arena such a great place to be.

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Above all, this is *your* column. I welcome input on the content and direction of the column from you, the reader. My e-mail address is <k7sz@arrl.net>, so feel free to write to me and let me know what you want me to cover in future issues of *CQ VHF*.

On a personal note, I am all for taking the least expensive road to meet a particular communications task. That means buying used gear, scrounging parts (along with "dead" gear) for simple (and sometimes complex) homebrew projects for the shack. This includes recycling old TV antennas, computer equipment, and even TV antenna rotors! Not only does this tack save you money (and with the current state of our economy that is a very attractive idea), but it gets you, the newcomer to VHF+, to take a proactive part in your pursuit of the hobby. After all, ham radio is a technical hobby, so don't be afraid to become fully immersed in building accessory projects for your station. The QRP crowd that I still hang out with is positively overcrowded with avid homebrewers, proving that the art and science of "rolling your own" gear is not a lost art! The same can be said of the VHF+ operators. As a matter of fact, it seems that the higher in frequency you go, the more you encounter a whole group of homebrew aficionados. Don't worry if you can't tell the difference between the ends of a soldering iron. We'll address that, too, in this column!

With the FCC's doing away with the CW requirement for obtaining a ham ticket, the pathway to ham radio has become much easier over the last several years. While I do not agree with those who believe that CW is an archaic method of communications, I do respect their opinion. In reality, using CW is an art in itself, and while not necessary to obtain a license, it is a good thing to master, since there are times when voice and data modes are not reliable, but CW will still get the message through.

The influx of new Technician class license holders to the VHF/UHF spectrum has been astounding. New FM repeaters are popping up all over. The "challenge" to becoming operational on the 2-meter FM band is directly related to the size of your bank account. A 2-meter handheld costs about $125 and allows the user to access simplex and local repeater channels with very little outlay of cash and virtually no commitment to external antennas, feedlines, etc. On the other end of the spectrum is the serious VHF/UHF DXer/contester who has a ton of money invested in top-of-the-line transceivers, mast-mounted receiver preamplifiers, high-power RF linear amplifiers, hardline coaxial transmission line, tall towers, and stacked arrays of antennas. You and I are most likely somewhere in the middle of these two extremes.

Often we tend to trivialize 2-meter FM operations. My first exposure to 2-meter FM was during college in the late 1960s. I picked up a converted Motorola "luggable" transceiver that, with a full set of batteries, weighed in at around 15 pounds! It was a single-channel radio set *but it was a Motorola!* The thing ate batteries like mad—two 45-volt B+ batteries plus several D cells for filaments and bias supply. All in all, it was an "adventure" to lug around that old Motorola. My mobile rig at that time was a converted RCA dual-channel commercial FM set that came out of service on the local taxi company frequencies. Today, when I look at my little Yaesu VX-150 2-meter synthesized HT, I fondly think back to my early days in FM. We have come a long way, that's for sure.

It took quite a few years for 2-meter FM to become popular. Autopatch repeaters became fashionable during the mid-1970s, and making telephone calls via the repeater from your mobile was ultra-cool! Today, 2-meter FM operations are the backbone of ham radio, especially in the ARES (Amateur Radio

Emergency Service) and RACES (Radio Amateur Civil Emergency Service) arenas. The fact that hams can provide mobile/portable communications to aid in the mitigation of natural and/or man-made disasters is something we all can take pride in. Without 2-meter FM, that facet of our hobby would be hard-pressed to provide top-notch emergency communications for the Red Cross, the Salvation Army, and local and regional EOCs (Emergency Operations Centers), not to mention the Department of Homeland Security.

CQ VHF has a long history of providing coverage in the radio hobby press of VHF FM communications with a special emphasis on EmComm (emergency communications). Since this is a beginners' column, let's begin with the ham radio version of the old country "Party Line" from the early days of the telephone.

Two-meter FM literally is found in almost every ham shack on the planet. If you want to get an idea of the proliferation of VHF/UHF repeaters that are active in the U.S. and Canada, procure a copy of the ARRL's "Travel Plus for Repeaters" and compile a list of active repeaters within a 50-mile radius of your home. It is staggering . . . down right frightening at times! Many of these "machines" have backup power along with extensive features geared specifically toward the EmComm mission. APRS (Automatic Position Reporting System) repeaters have blossomed all over the country, allowing hams running APRS software to keep tabs on stations as they move across the country and in outer space! Yup, the ISS (International Space Station) has been tracked by terrestrial APRS stations in real time.

D-Star, the newest digital FM radio system to come from Japan, offers EmComm operators the advantage of a digital radio system for passing emergency traffic and data that would be laborious using standard analog FM systems.

Those areas of the country that suffer recurring large-scale disasters, such as the floods in the Midwest and the California wild fires each year, have extremely active ARES/RACES groups. If you are interested, and I hope you are, contact the ARRL, 225 Main Street, Newington, CT 06111, for information about ARES/RACES EmComm support groups in your particular area.

Recently, my wife Patricia, KB3MCT, and I relocated from northeastern Pennsylvania to Dacula, Georgia, in Gwinnett County. Both of us were active in the Luzerne County ARES group in our former area, and when we arrived in Dacula, we immediately set out to find the local EmComm group and volunteer our services. It turns out that the local 2-meter repeater, 147.075 (+600 kHz, PL: 82.5 Hz) is the place to be on Monday evenings. The Gwinnett Amateur Radio Society has a club net at 2000 hours local time followed by an ARES net at 2100 hours local. The thing that immediately struck both of us was the total professionalism displayed by the net control stations, or NCS (they use two, one the primary NCS and a backup NCS for training purposes), and the people checking into both of these nets. Later I found out that the Gwinnett ARES group is the largest in the state and has an extensive training program for aspiring emergency communicators *before* they can be deployed in support of a local served agency during an emergency. In a word, the Gwinnett ARES group takes EmComm very seriously!

Gwinnett County has been divided into several sections, with Gwinnett ARES members assigned to one of these sections. In the event of a real-world emergency or disaster, this method assures that the right, properly trained people are in place at the right time and in the proper location to be of maximum usefulness to the professional disaster response teams. There are even two specialized teams, one that deploys to the Gwinnett County EOC and one that handles the mobile ARES comm facilities.

Trivialize 2-meter FM ops all you want, but this type of emergency readiness is something to be proud of. Historically this group of EmComm operators has an outstanding professional relationship with their served agencies and has become an integral part of the Gwinnett County disaster mitigation plans.

OK, so what have we learned so far? First, the exposure that the majority of new radio amateurs have to VHF+ is relegated to 2-meter FM operations. This band and the associated equipment to become operational are well within the confines of the most frugal of budgets. New 2-meter FM gear costs around $125 upwards, depending upon power and features of the radio gear. Antennas are manageable and, in a pinch, a 2-meter ground-plane antenna can be made from coat hangers (talk about dirt cheap!).

Two meters is the modern-day version of the old-style party-line telephone. Many non-hams have the local simplex and repeater frequencies plugged into their scanner receivers, so understand that what you say on 2 meters FM has an enormous audience.

The fact that 2 meters is so vastly populated by radio amateurs and the frequencies are similar (propagation wise) to EMS/fire/police frequencies makes 2 meters FM *the* band for ham radio emergency communications. Additionally, part of your licensing requirements dictate that you are supposed to provide emergency communications when and where needed. Therefore, becoming properly trained in net operations and EmComm procedures is paramount to becoming active with a local ARES/RACES group. Here again, the ARRL has stepped in and offers on-line emergency communications certification, so there is no reason not to be trained and participate when needed. Check the website <www.arrl.org> and follow the links to the League's EmComm courses.

Setting aside the EmComm aspect of 2-meter FM operations for a moment, let's explore one of the more amazing things you can engage in on 2 meters. Did you realize that you can contact the International Space Station or work 2-meter FM DX via AMSAT-OSCAR 51, a LEO (low Earth orbit) amateur radio satellite, using nothing more complicated than a dual-band VHF/UHF handheld radio along with a manually pointed Yagi antenna? Literally, for well under $300 you can assemble a very simple VHF/ UHF dual-band SatCom (satellite communications) Earth station! You can even do it much cheaper than that if you can scrounge or buy a used VHF/UHF HT and make the antenna yourself! That should hammer home the idea that 2 meters FM isn't just for ragchewing anymore!

OK, gang that wraps it up for this installment. I hope that you newcomers to the VHF+ arena are ready to get intimately familiar with this aspect of the radio hobby. We barely covered the basics of the 2-meter band and the FM mode of communications. In addition to FM, there is VHF/UHF weak-signal work and satellite communications using SSB/CW, and digital modes using FSK. Then there is the digital radio explosion, APRS (Automatic Position Reporting System), and a whole host of other ingenious operating modes to explore. So tighten your seat belt, 'cuz we're gonna have some fun!

73, Rich, K7SZ

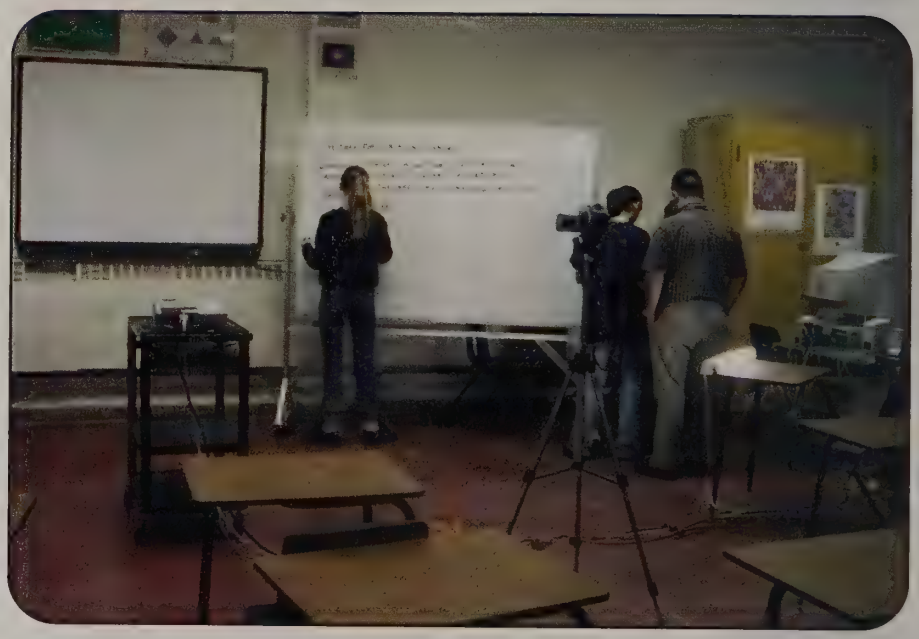
By Miguel Enriquez, KD7RPP

ATV Gives Impetus To New Math/Science Curriculum

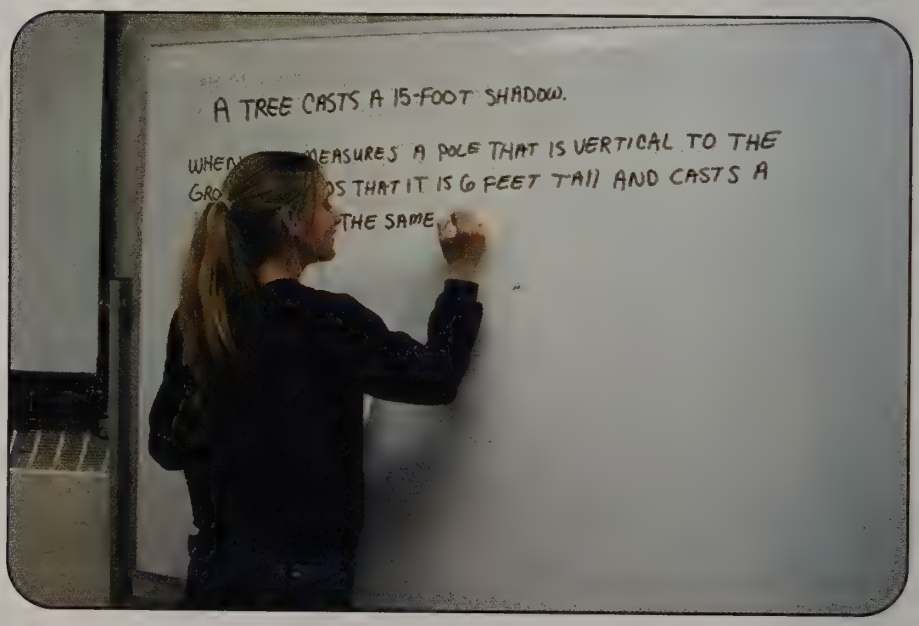
The successes that the Pueblo Amateur Radio and Underwater Robotics Club have had in past two years using ATV in the classroom provided some recent interesting developments for the way we teach math here at Pueblo Magnet High School in Tucson, Arizona. I had been approached earlier in the school year by Tucson Unified School Administrators who wanted to explore the possibility of designing a curriculum that would employ ham radio and other wireless technologies to teach math and science. What the administrators had in mind when they first proposed this new venture was extending to the general population the fun and advancements in math test scores the Pueblo ARC students were experiencing.

My initial reaction to their request was "I'm not sure how that would work." However, as I thought about the possibilities, I realized that their request was not one of adding electronics to the existing math and science curriculum, but rather the request was for the creation of an entirely new curriculum. My first thought was to run to the internet to see if such a curriculum with specific references to state standards existed. There was none.

My second thought was to unashamedly copy someone else's model; I found none. The best I came up with was a curriculum Mark Spencer, WA8SME, ARRL Education and Technology Coordinator, had written. That was very useful to me but lacked references to state standards. I next looked to see if anyone was making headway with the melding of ham radio with state standards. I had recently received an e-mail from a fellow ARRL Education and Technology



Edith, Sara, and José Velasco review ham-radio/math-lesson presentation material prior to videotaping.



Edith spell checks her math problem on the whiteboard before instructing how to easily compute the height of an antenna using shadows.

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Program Instructor, Nathan McCray, (K9CPO, in which he reported success with a proposal he had made to his own school district for the use of ham radio in the classroom. Nathan, an assistant principal with the Vion School District #6 in Wisconsin, had painstakingly juxtaposed amateur radio activities to Wisconsin State Standards in such a way that it made sense to a member of his school board.

I then set about copying as much of Nathan's proposal as was relevant to Arizona State Standards. The going was easier than I believed it would be. My initial presentation to the TUSD administrators who had first contacted me was met with "This is good. This we can do." For the following six weeks I used every spare moment I could find refining that curriculum proposal.

The upshot was that the one class I had been asked to teach on a trial basis has now become a full-time job for me this year. The good news is that the school will now support our ham radio and ATV activities with resources and support from technology education funding sources, where before we relied solely on donations to the Pueblo ARC for operating expenses. The good news is that we are now also planning to offer a ham radio course during summer school this year for students coming to Pueblo Magnet High School in August 2009.

And the best news is that we will have a laboratory setting, of sorts, this year where we can demonstrate to the general public what we hams have known for over a hundred years—that ham radio is not only fun and practical and relevant, but that it can be used to help our students perform better in school by making their education more relevant and practical.

A lot of work still remains to be done, and I have until August of 2009 to finetune the new ham radio and wireless technologies curriculum before we start using it. However, in the meantime we will continue having fun with ham radio while adding more ATV activities to our daily classroom lesson delivery.

What I failed to mention earlier was that the reason I was approached in the first place to write such a curriculum was because the local community in TUSD is aware of the exciting activities our ATV station is providing for our students and had noted the significant improvements those students are demonstrating.

73, Miguel, KD7RPP

By Mark Thompson, WB9QZB

DIGITAL RADIO

Digital Technology on VHF, UHF, and Microwaves

Hosting a Digital Conference

Those of you who read *CQ VHF* Editor Joe Lynch, N6CL's "Line of Sight" editorial will have noticed in the Fall 2008 issue that Joe covered the ARRL/TAPR DCC (Digital Communications Conference) in Chicago. I was the local co-host of the 2008 DCC in Chicago along with Kermit Carlson, W9XA. In this issue I will discuss planning and organizing a digital conference.

History

In the mid-1980s I became involved and active in packet radio. Packet radio grew dramatically from the mid-1980s through the mid-1990s. In many areas local packet clubs were established. In the Chicago area CAPRA (Chicago Area Packet Radio Association) was established to educate hams about packet and build backbone links. CAPRA grew quite quickly, like packet radio, and had monthly meetings.

Because packet was a new technology, many hams were very interested in learning about it. CAPRA hosted packet forums at local hamfests, and in 1990 CAPRA sponsored a packet radio day on a Sunday in October. We invited Kantronics to present at the event. A CAPRA member, George Dorner, W9ZSJ, was a dean at a local community college and arranged for the club to use an auditorium for the event. We didn't require registration in advance and were astounded when 200 hams participated in the event. In 1992 and 1994 we hosted the event again in conjunction with Kantronics.

The first TAPR annual meeting was held in 1995 in St. Louis. In 1996 TAPR and the ARRL jointly organized the first annual DCC in Seattle.

In 1997 we submitted a proposal to TAPR to host the 1998 DCC. While we had never hosted a national event before, we did have some experience with hosting the well-attended Kantronics packet days a few years earlier. Carl Bergstedt, K9VXW, and I were the local co-hosts.

The first task was to find a hotel at which to hold the DCC. We worked with TAPR to determine the hotel requirements for a DCC. One critical objective was to keep the hotel cost affordable for both the TAPR organization and the attendees. The annual W9DXCC DX conference held their event at a Holiday Inn in northwest suburban Chicago. We visited the hotel and met with its conference representative. The hotel seemed to meet TAPR's requirements and we recommended the hotel to TAPR.

At that point, TAPR took responsibility for negotiating the contract with the hotel. As local co-hosts, we worked with TAPR to assist in logistics. The DCC was well attended, with the the ARRL, FCC, and major manufacturers present. In fact, Kenwood debuted its first prototype of a packet/APRS HT at the second annual APRS national symposium at the DCC. The agenda and presentation audio of the 1998 DCC are available at <http://www.tapr.org/conf_dcc1998.html>.

After the 1998 DCC conference, packet radio and packet clubs in most areas began to decline. However, new digital technologies such as PSK31 were developed and introduced at subsequent DCCs.

In early 2007 we decided it was time to bring the DCC back to Chicago. Although the local CAPRA club was no longer active, Kermit Carlson, W9XA, agreed to be a local co-host with me. We submitted a proposal to TAPR to host a future DCC, and the TAPR board decided we could host the 2008 DCC. We reviewed with TAPR the 2006 and 2007 DCCs to better understand their requirements.

Kermit had experience with the local W9DXCC DX conference. A few years earlier, W9DXCC had moved to a different Holiday Inn a few miles closer to O'Hare Airport, and this included a free airport shuttle. I visited the hotel and met with the conference representative. It was obvious the hotel met TAPR's requirements for a DCC, including the cost objectives. I connected TAPR Vice President Steve Bible, N7HPR, with the hotel to negotiate the contract.

At previous DCCs the local host typically handed off the remainder of the planning and organizing to TAPR. However, Kermit and I decided we wanted to make this DCC one of the best ever. Therefore, we took a more active role in terms of promotion, local logistics, and planning the technical and introductory sessions. Kermit's participation in the W9DXCC conference included arranging the audio-visual equipment. Ron Steinberg, K9IKZ, owns an A/V business and annually deploys an outstanding array of A/V equipment at the W9DXCC conference.

The DCC was scheduled after W9DXCC in order to not conflict with it or any local hamfest. Kermit worked with Ron to store the A/V equipment at the hotel after W9DXCC and redeploy it at the DCC the following weekend. Not only did his save both the W9DXCC and the DCC conferences money, but it provided the DCC with a level of professional A/V equipment not used at previous DCCs. Kermit and Ron's execution of the A/V equipment was flawless, and both the TAPR Board of Directors and attendees agreed it was the best ever A/V presentation at a DCC.

I worked to promote the DCC both nationally and locally. We actively solicited hams to submit papers for inclusion in the conference *Proceedings* and to present them at the DCC. A number of firsts occurred at the 2008 DCC: The new mode WINMOR was debuted, and the first D-STAR Friday Night Get Together was held. Some of the most significant innovators in D-STAR technology presented at the DCC and the Friday night event. Prior to the DCC, Kermit and TAPR President Dave Toth, VE3GYQ, configured the D-STAR repeater equipment donated by ICOM and got the internet gateway up and running so hams in the hotel could make worldwide D-STAR contacts.

I believe that it is important for hams of all levels of digital experience to attend

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the DCC. Therefore, we scheduled a separate introductory track on Saturday with several presentations covering HF Digital Voice, D-STAR, and HF Digital Data Modes.

Both ICOM and Kenwood, as well as other participants, demonstrated their digital equipment at the DCC. Joe Lynch, N6CL, provided every attendee with a copy of *CQ VHF* magazine, and ICOM provided an IC-91AD FM/D-STAR HT as a prize at the Saturday night banquet.

We invited Hap Holly, KC9RP, of the RAIN Report to attend the DCC. He interviewed many of the presenters for his weekly RAIN Report. You can hear these interviews over the course of the year at <http://www.therainreport.com>.

We invited Gary Pearce, KN4AQ, of Amateur Radio Video News to record the DCC sessions. Gary recorded nearly every session and is editing them into a set of DVDs for release in early 2009. You can learn more about Amateur Radio Video News at <http://www.arvideonews.com>.

We are exploring streaming the DCC to the internet. Because there is a registration fee for those who attend the DCC, there also would be a fee for the online registrants. However, it would allow those who cannot travel to the DCC to be able to see a DCC in real time. Even so, it should be stressed that one of the major benefits of the DCC is to actually attend and talk with other attendees.

Typically, every year the DCC moves to a new location approximately from the eastern part of the country to the Midwest to the West Coast. The TAPR Board of Directors decided to do another first and return the DCC to Chicago in 2009. This will make the planning of the DCC significantly easier and let us focus on promoting the DCC and soliciting papers and presentations to make it an even better DCC this year.

I encourage everyone who has an interest in digital voice and data communications to attend the DCC. If you have experience using digital technology or innovating new digital ideas, please consider submitting a paper to be included in the *Proceedings* and perhaps present your paper at the DCC. You can learn more about the 2009 DCC at <http://www.tapr.org/dcc.html>.

I look forward to seeing many of you at the Dayton Hamvention® in May and also at the DCC in Chicago in September.

73, Mark, WB9QZB

By Keith Pugh,* W5IU

SATELLITES

Artificially Propagating Signals Through Space

The 2008 AMSAT Space Symposium and Annual Meeting

In my last column I mentioned the 2008 AMSAT Space Symposium in Atlanta, Georgia. It occurred too late to make the last column deadline. Also, I nearly missed it this year due to a travel commitment with members of my church, but I managed to get there for the Saturday afternoon and evening sessions plus Sunday morning's Field Ops Breakfast and other activities.

I usually attend the Board of Directors Meeting, but it was held before the symposium while I was still traveling with the church group. A new slate of officers was elected by the BOD, led by a new President, Barry Baines, WD4ASW. Barry is a long-time BOD member and has served in various capacities over the years. In my opinion, he is an excellent choice for the times. These are trying times for AMSAT with a turnover in engineering personnel, another re-location of the laboratory coming up, increasing pressure for a High Earth Orbit (HEO) satellite, and no affordable launch opportunities. Barry is forming teams to tackle these challenges and the effort is well under way.

I arrived as Frank Bauer, KA3HDO, AMSAT V.P. for Human Spaceflight and ARISS International Chairman was giving his presentation on ARISS (Amateur Radio on the International Space Station). This has been a good year for ARISS, with school contacts approaching the 400 mark since launch in 1998. Work is progressing satisfactorily on SuitSat II and other projects.

The Saturday banquet speaker was Dan Shultz, N8FGV. Dan has worked for many years on the Hubble Telescope and gave an absolutely fascinating account of Hubble's history and preparations for the Hubble repair mission next year. Dan's dry humor and knowledge kept the audience's attention riveted on the topic and even kept me awake while I was suffering from a severe case of jet lag.

The annual Field Ops Breakfast was chaired by Gould Smith, WA4SXM, AMSAT V.P. of User Services, and was well attended. Gould outlined the progress made in 2008 and the plans for 2009. The AMSAT Field Ops are Area Coordinators who form the "first line" representing AMSAT at hamfests, radio club meetings, AMSAT nets, "Elmering," and other functions. It is always a challenge for field ops to present a positive image to the amateur radio public and others regarding amateur satellites when the average ham thinks that satellites and satellite communications are beyond their comprehension and their pocket book. This is particularly difficult in these times of no affordable High Earth Orbit launches as well as no HEO satellites currently operational.

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AMSAT is always looking for additional Area Coordinators to help in this effort. We still do not have Area Coordinators in several states, and we could use more in some of the larger metropolitan areas. In some areas, we have Area Coordinators on the books who are no longer active. These Area Coordinators need to be replaced. In case you haven't recognized it already, this is a "shameless plea" for help. All that is required to become an Area Coordinator is a love for amateur satellites, a willingness to learn and keep abreast of the topic, and some time to devote to attending and making presentations at amateur radio club meetings, hamfests, etc. Your reward is the satisfaction of a job well done and sharing your favorite avocation with your peers. After all, AMSAT is an "Equal Opportunity Exploiter."

AMSAT History Lessons

AMSAT's 40th Anniversary: The first amateur radio satellite, OSCAR-1, was launched on December 12, 1961, just over four years after Sputnik-1 on October 4, 1957. The Project OSCAR Group in California built and coordinated this launch. By 1969 the needs of the amateur radio satellite community had outgrown this operation, and a group of devoted satellite people in the Washington, DC area formed the Radio Amateur Satellite Corporation, or AMSAT. The year 2009 marks the 40th anniversary of the formation of AMSAT. To celebrate this anniversary, the 2009 AMSAT Space Symposium and Annual Meeting will be held in the Washington, DC and Baltimore, MD area in October 2009. This should be a gala occasion and worthy of your attendance. I attended the AMSAT 30th anniversary event hosted by the same group in 1999 and thoroughly enjoyed it. Please put it on your calendar now! Additional 40th anniversary activities are being planned for the Dayton Hamvention® and other functions in 2009.

At the same time and place, the ARISS broup will be hosting an ARISS Operations "Face-to-Face" meeting. It will be an excellent chance to meet and greet both AMSAT and ARISS people. ARISS Operations people are the worldwide, day-to-day mentors, planners, and coordinators for ARISS. They normally meet at least once a week via teleconference and are in constant touch by e-mail. This will be the first "Face-to-Face" meeting of this group.

25th Anniversary of Amateur Radio Human Spaceflight: In 1983, Owen Garroitt, W5LFL, flew on the Space Shuttle Columbia during mission STS-9 and carried amateur radio equipment with him. He made many contacts on this mission, including one with King Hussein of Jordan, JY1. I was one of the eager participants in this operation and planned

"The year 2008 was historic for AMSAT and ARISS. The year 2009 will be even bigger. Take part in the planned activities and plan to make 2009 the year you become active on the "birds" or increase your activity if you have not been very involved."

to make a contact as well. One of the local television stations covered the attempt from my ham shack. Only the "big guns" in the U.S. were successful. We learned first hand about the FM "capture effect" on this mission, but everyone had fun anyway. This was the start of 25 years of successful manned spaceflight operations on board the Space Shuttle, MIR, and ISS.

Just 25 years later, Owen's son Richard Garriott, W5KWQ, flew on the ISS to celebrate this occasion. His ten days in space created a memorable event in late October 2008. He made several hundred voice QSOs, a number of school contacts, several special event contacts, and sent down a number of SSTV pictures.

Richard's flight started the 25th anniversary celebration that was being carried on throughout the end of 2008 and into January 2009. Special modes and operations were being exercised on the ISS to commemorate this event and initial reaction has been very positive as of this writing.

If you made any kind of contact with the ISS during this event, details of how to apply for special certificates can be found at <http://www.ariss.org>.

Ten Years of Operation on the ISS: As mentioned above, the first elements of the ISS were launched in 1998, and 10 years later it is nearly complete. During this time nearly 400 school contacts have been made between students and the astronauts. The 400th contact is scheduled to occur in January 2009. In addition to the school contacts, several of the astronauts have taken a special interest in making many hams happy with a space contact, and contacts have been made on all continents, all states, and over 130 DXCC countries. The ISS has also been used as a digipeater, a cross-band voice repeater, a launch platform for other satellites (PCSAT, SuitSat, etc.), and will be used even more in the future. Starting in 2009 the crew will be increased from the current three to a full complement of six. The additional crew members will have a definite impact on amateur radio operation. This will present a challenge to the scheduling of operations.

Summary

The year 2008 was historic for AMSAT and ARISS. The year 2009 will be even bigger. Take part in the planned activities and plan to make 2009 the year you become active on the "birds" or increase your activity if you have not been very involved.

Don't forget to support AMSAT in its education and fundraising efforts so that we can continue to put more "birds" on the air. In particular, support Phase IIIE, Eagle, and the Intelsat Phase IV Ride Share projects so that we can get back into the HEO satellite business.

'Til next time!

73, Keith, W5IU

By Bill Brown,* WB8ELK

UP IN THE AIR

New Heights for Amateur Radio

Tracking Beacon

No matter how many APRS trackers you may have on a balloon flight, there is always a chance that they all will fail. In that event, it's a good idea to have some backup. In those situations a low-cost, low-power transmitter can really save the day. This circuit also makes a great hidden-transmitter foxhunt device.

One of my favorite gadget supply houses on the internet is called SparkFun Electronics (www.sparkfun.com). Almost everything needed to build this tracking transmitter can be found on this website. The transmitter module we will be using is an 8-milliwatt transmitter module that operates on 434 MHz and currently costs just $3.95. There are only four leads on the module: Vcc, Ground, Data (the on/off control line), and the antenna output. It's a natural for sending a Morse Code message since you can key it on and off with just one input line that can be controlled by a logic signal from a microcontroller. The module is listed under the "Wireless" section and is called the RF Link Transmitter – 434 MHz, order number WRL-08946. One nice feature of using this module is that it's operating at a license-free power level and can be used as a radio-control (R/C) and model-rocket locator.

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The Arduino Controller

The brain behind the tracking transmitter is based on the Atmel AVR Mega168 microcontroller and is called the Arduino Stamp (SparkFun #DEV-08164). The Arduino is similar in appearance and size to the classic Parallax Basic Stamp but is programmable in the C language. This is a very powerful system and a great way to learn the basics of C programming. The Arduino system puts all the low-level items that make C programming tedious into the background and provides you with loads of high-level routines for performing A-to-D conversions, timing delays, serial communications, and digital I/O with very simple and easy-to-use commands. The best part of the system is that the Arduino development software is totally free (www.arduino.cc).

In addition, no expensive external programmer is needed, since you can program the Arduino Stamp via a serial connection (via the internal bootloader program in the microcontroller). Keep in mind that the Arduino Stamp has logic level serial connections so you will have to use a serial converter IC such as the MAX232 to interface to your computer. However, SparkFun does carry a useful USB module that will connect to the Arduino Stamp with just two serial lines and a common ground. It's called the Arduino Serial USB Board and is SparkFun item #DEV-08165. The Arduino website shows how to hook up the USB converter board to the Arduino Stamp on a prototype board (http://arduino.cc/en/Guide/ArduinoMini). Photo A shows my prototyping setup of the complete tracking transmitter, which includes the USB module to program the circuit. See figure 1 for the tracking beacon schematic.

Tracking Beacon Program

The easiest way to generate Morse Code is via a lookup table based on the

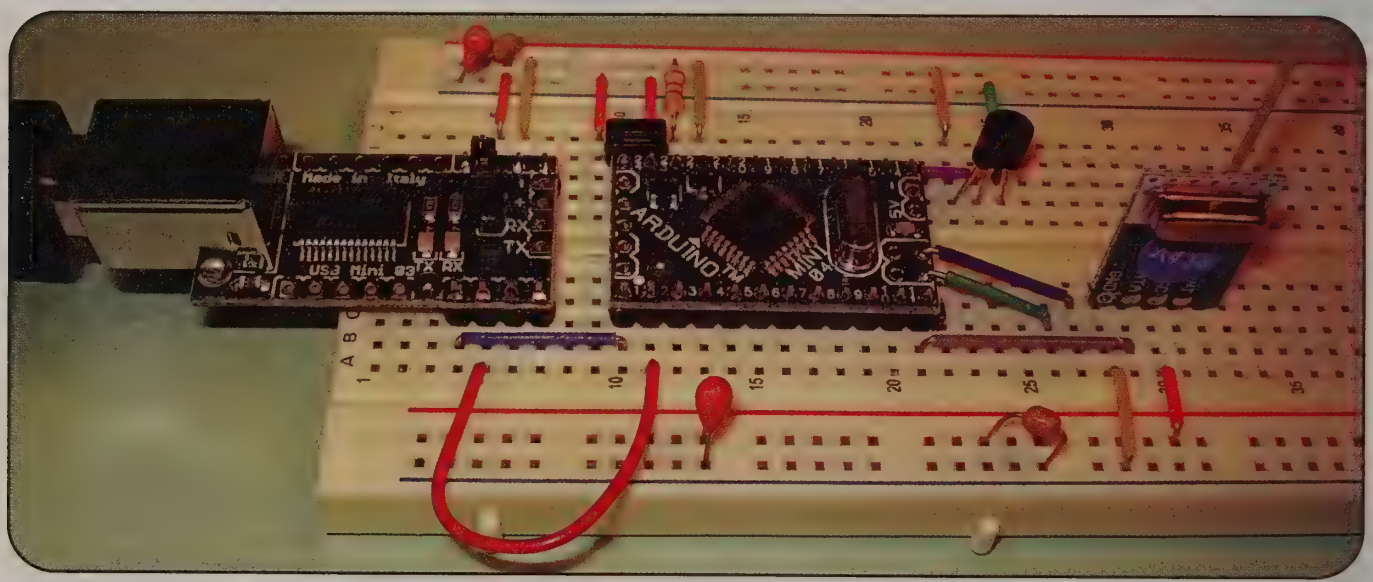

Photo A. Prototype board of the tracking beacon showing the USB converter, the Arduino Stamp, and the 434-MHz transmitter module.

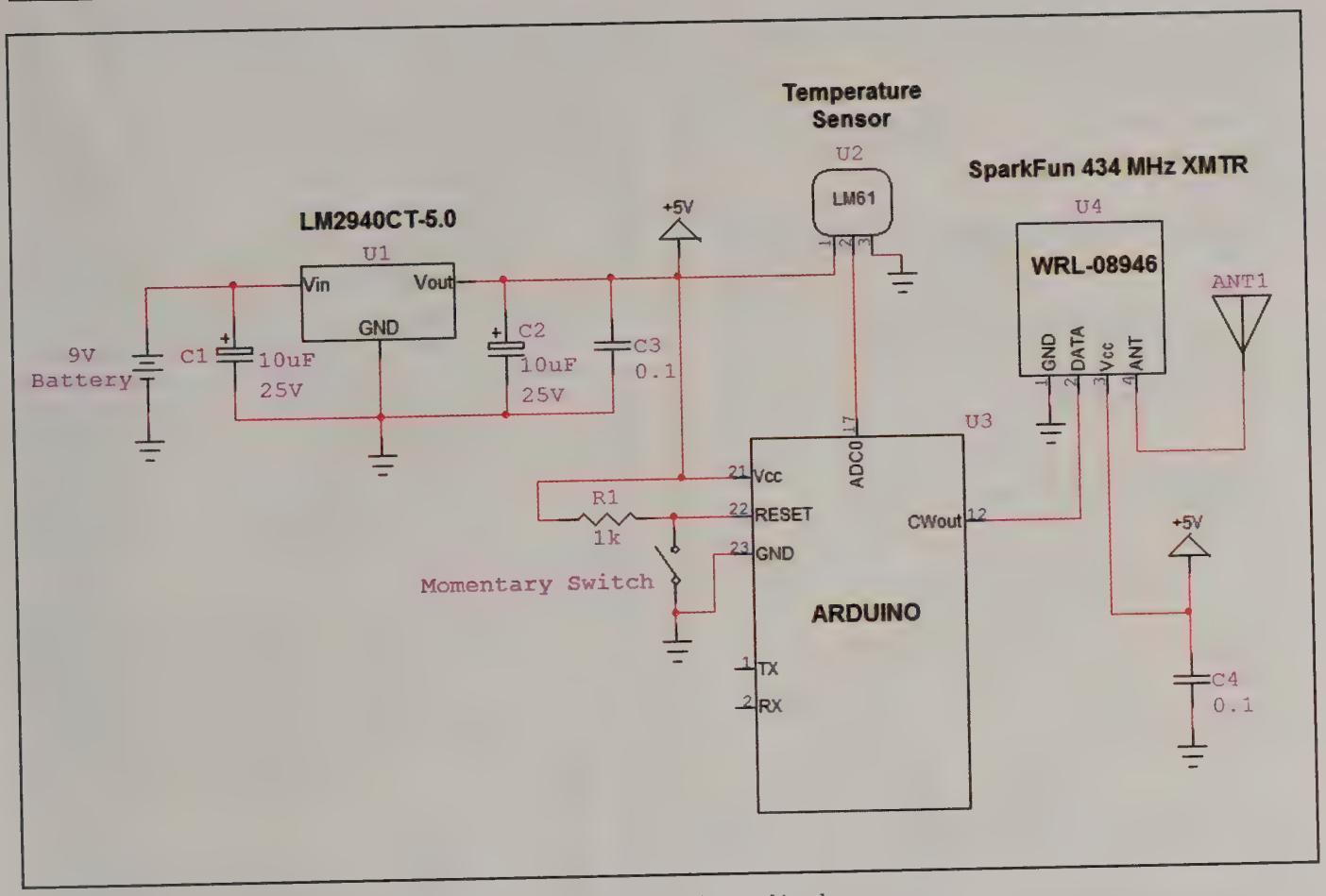

Figure 1. Schematic of the tracking beacon.

ASCII value of the character you want to send. The trick is to enter the data for each character so it can handle a variable length Morse Code output. This is done by entering an 8-bit character so that a 1 is a DIT and a 0 is a DAH. Then you have to append a last 1 bit to be the "end of character" flag. Since we will be shifting out the 8-bit data associated with each Morse Code character to the right, we'll have to enter the Morse Code data from right to left. To send the Morse character, you shift the 8-bit value one bit at a time to the right and check to see if the LSB (least significant bit) is a 1 or a 0 and then send out the appropriate DIT or DAH. For example, the number "2" in Morse Code would be represented as 00100011 (hint: you have to think right to left). When the leftmost one-bit gets shifted right to the least significant bit (LSB), the total 8-bit value now is just 1 and is used as the end-of-character flag and is not transmitted out. Once you get past the mind-warping effect of entering Morse Code data from right to left

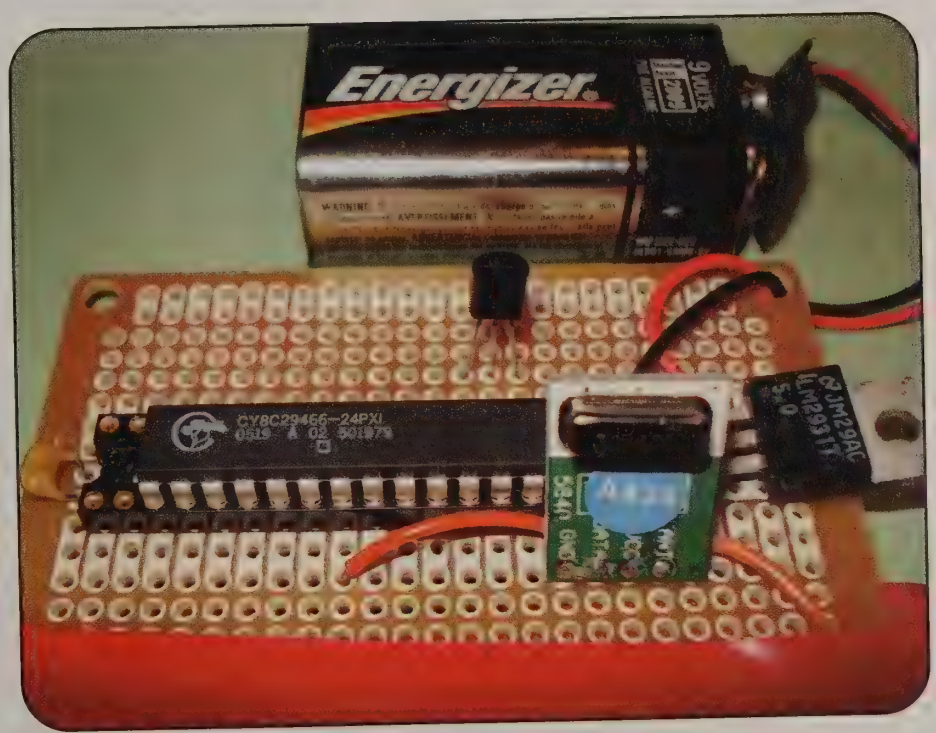

Photo B. Flight-ready version of the tracking beacon.

```
//*************************************
// CW output function  - keyed CW
//*************************************
void sendcw(int cwchar)
{
 morse = morse_table[cwchar-0x20];
while(1){

   if(cwchar == ' '){ // if SPACE character then delay 500 mSec between words
     delay(500);
     return;
   }

   if (morse & 0b00000001){ // compare LSB [ 1=Dit  0=Dah ]
     digitalWrite(cwoutPin, HIGH);
     delay(100); // Dit timing - 100 msec
     digitalWrite(cwoutPin, LOW);
     delay(100);
   }
   else{
     digitalWrite(cwoutPin, HIGH);
     delay(300); // Dah timing - 300 msec
     digitalWrite(cwoutPin, LOW);
     delay(100);
   }

   morse = morse >> 1; // shift right to see if Dit or Dah

  if(morse == 1){ // if the value is 1 then end of CW character
     delay(200);
     return;
   }
  } // End of Morse while loop
} // End of SENDCW routine
```

Figure 2. The C routine to send keyed Morse Code. the full program can be downloaded at <http:/www.wb8elk.com/>.

```
// CW output function - AM modulation version *
void sendcw(int cwchar)
{
 morse = morse_table[cwchar-0x20];
while(1){
   if(cwchar == ' '){ // if SPACE character then delay 500 mSec between words
     delay(500);
     return;
   }
   if (morse & 0b00000001){ // Compare LSB [ 1 = Dit  0 = Dah ]
      for(tone=0;tone<100;tone++){ // Dit timing
          digitalWrite(cwoutPin, HIGH);
          delayMicroseconds(500);
          digitalWrite(cwoutPin, LOW);
          delayMicroseconds(500);
      }
     delay(100);
   }
   else{
      for(tone=0;tone<300;tone++){ // Dah timing
          digitalWrite(cwoutPin, HIGH);
          delayMicroseconds(500);
          digitalWrite(cwoutPin, LOW);
          delayMicroseconds(500);
      }
     delay(100);
   }
   morse = morse >> 1; // shift right to see if Dit or Dah
   if(morse == 1){ // if the value is 1 then end of CW character
     delay(200);
     return;
   }
  } // End of Morse while loop
} // End of SENDCW routine
```

Figure 3. sendcw() routine modification for AM modulation.

in the lookup table, this does give you an easy way of sending variable-length characters without a lot of fuss.

Just change the callsign section to your call or message, load it into your Arduino Stamp, and you're ready to go. It will send your callsign and message along with the A/D value of the LM61 temperature sensor. The entire C program for keyed and AM modulated Morse Code complete with the Morse Lookup table can be downlaoded from the "Projects" section of the following website: <http://www.w8elk.com/>. The sendcw () routine for keyed CW is shown in figure 2.

One thing to consider is that you will have to use a multi-mode radio capable of CW mode. Also, the 434-MHz module does drift in frequency with temperature. Using insulation will help to control the temperature changes and therefore will slow the frequency drift. Surprisingly, just three layers of small-cell clear bubble-wrap will act as a greenhouse effect and will minimize temperature problems. This technique also helps to keep your tracking beacon lightweight. My last few beacons have weighed in at under three ounces when used with a lithium 9-volt battery.

There is one trick that can be written in software to eliminate the drift problem. You can turn the transmitter module on and off rapidly enough to create an AM modulated audio tone. See figure 3 for the AM modulation code modification for the sendcw() routine. This will allow the use of radios and scanners that can receive AM mode. You may have to slightly retune a bit during the flight, but the audio tone of the Morse Code will remain the same.

Receive System

To receive on the ground, I recommend as a minimum a three-element Yagi (such as the 70-cm Arrow). It also will help to include a 70-cm preamp (I use the Advanced Receiver Research P432VDG; <www.advancedreceiver.com>). Once on the ground, I've been able to hear it out to over a mile or two away (10 miles or more when up in a tree). With the low power output, it's easy to home in on it via signal strength and walk right up to it using direction-finding (DF) techniques. I've had good reception out to over 100 miles downrange during a flight.

Time to Fly

You won't have to fly the USB converter module, so I just use the breadboard prototype to program the Arduino Stamp and then put the Arduino into the IC socket on the tracking transmitter board with attached antenna for flight. (See photo B for an example of the flight transmitter. This version used a PSoC microcontroller, which has a steep learning curve. I use the Arduino Stamp in its place for an easier implementation.) The antenna is just a half-wave wire dipole held in place by a small wooden-dowel rod.

You can download the code for the tracking trasnmitter from the "Projects" sectionof the following website: <http://www.wb8elk.com/>. There you will also find variations for AM modulation, Hellschreiber mode, as well as a number of other tracker circuits that include pressure altitude and GPS encoding with RTTY, Morse Code, and MFSK modes.

73, Bill, WB8ELK

CQ's 6 Meter and Satellite WAZ Awards

(As of January 1, 2009)

By Floyd Gerald,* N5FG, CQ WAZ Award Manager

6 Meter Worked All Zones

No.	Callsign	Zones needed to have all 40 confirmed
1	N4CH	16,17,18,19,20,21,22,23,24,25,26,28,29,34,39
2	N4MM	17,18,19,21,22,23,24,26.28.29,34
3	JI1CQA	2,18,34,40
4	K5UR	2,16,17,18,19,21,22,23,24,26,27,28,29,34,39
5	EH7KW	1,2,6,18,19,23
6	K6EID	17,18,19,21,22,23,24,26,28,29,34,39
7	KØFF	16,17,18,19,20,21,22,23,24,26,27,28,29,34
8	JF1IRW	2,40
9	K2ZD	2,16,17,18,19,21,22,23,24,26, 28,29,34
10	W4VHF	16,17,18,19,21,22,23,24,25,26,28,29,34,39
11	GØLCS	1,2,3,6,7,12,18,19,22,23,25,28,30,31,32
12	JR2AUE	2,18,34,40
13	K2MUB	16,17,18,19,21,22,23,24,26,28,29,34
14	AE4RO	16,17,18,19,21,22,23,24,26,28,29,34,37
15	DL3DXX	18,19,23,31,32
16	W5OZI	2,16,17,18,19,20,21,22,23,24,26,28,34,39,40
17	WA6PEV	3,4,16,17,18,19,20,21,22,23,24,26,29,34,39
18	9A8A	1,2,3,6,7,10,12,18,19,23,31
19	9A3JI	1,2,3,4,6,7,10,12,18,19,23,26,29,31,32
20	SP5EWY	1,2,3,4,6,9,10,12,18,19,23,26,31,32
21	W8PAT	16,17,18,19,20,21,22,23,24,26,28,29,30,34,39
22	K4CKS	16,17,18,19,21,22,23,24,26,28,29,34,36,39
23	HB9RUZ	1,2,3,6,7,9,10,18,19,23,31,32
24	JA3IW	2,5,18,34,40
25	IK1GPG	1,2,3,6,10,12,18,19,23,32
26	W1AIM	16,17,18,19,20,21,22,23,24,26,28,29,30,34
27	K1LPS	16,17,18,19,21,22,23,24,26,27,28,29,30,34,37
28	W3NZL	17,18,19,21,22,23,24,26,27,28,29,34
29	K1AE	2,16,17,18,19,21,22,23,24,25,26,28,29,30,34,36
30	IW9CER	1,2,6,18,19,23,26,29,32
31	IT9IPQ	1,2,3,6,18,19,23,26,29,32
32	G4BWP	1,2,3,6,12,18,19,22,23,24,30,31,32
33	LZ2CC	1
34	K6MIO/KH6	16,17,18,19,23,26,34,35,37,40
35	K3KYR	17,18,19,21,22,23,24,25,26,28,29,30,34
36	YV1DIG	1,2,17,18,19,21,23,24,26,27,29,34,40
37	KØAZ	16,17,18,19,21,22,23,24,26,28,29,34,39
38	WB8XX	17,18,19,21,22,23,24,26,28,29,34,37,39
39	K1MS	2,17,18,19,21,22,23,24,25,26,28,29,30,34
40	ES2RJ	1,2,3,10,12,13,19,23,32,39
41	NW5E	17,18,19,21,22,23,24,26,27,28,29,30,34,37,39
42	ON4AOI	1,18,19,23,32
43	N3DB	17,18,19,21,22,23,24,25,26,27,28,29,30,34,36
44	K4ZOO	2,16,17,18,19,21,22,23,24,25,26,27,28,29,34
45	G3VOF	1,3,12,18,19,23,28.29,31,32
46	ES2WX	1,2,3,10,12,13,19,31,32,39
47	IW2CAM	1,2,3,6,9,10,12,18,19,22,23,27,28,29,32
48	OE4WHG	1,2,3,6,7,10,12,13,18,19,23,28,32,40
49	TI5KD	2,17,18,19,21,22,23,26,27,34,35,37,38,39
50	W9RPM	2,17,18,19,21,22,23,24,26,29,34,37
51	N8KOL	17,18,19,21,22,23,24,26,28,29,30,34,35,39
52	K2YOF	17,18,19,21,22,23,24,25,26,28,29,30,32,34
53	WA1ECF	17,18,19,21,23,24,25,26,27,28,29,30,34,36
54	W4TJ	17,18,19,21,22,23,24,25,26,27,28,29,34,39
55	JM1SZY	2,18,34,40
56	SM6FHZ	1,2,3,6,12,18,19,23,31,32
57	N6KK	15,16,17,18,19,20,21,22,23,24,34,35,37,38,40
58	NH7RO	1,2,17,18,19,21,22,23,28,34,35,37,38,39,40
59	OK1MP	1,2,3,10,13,18,19,23,28,32
60	W9JUV	2,17,18,19,21,22,23,24,26,28,29,30,34
61	K9AB	2,16,17,18,19,21,22,23,24,26,28,29,30,34
62	W2MPK	2,12,17,18,19,21,22,23,24,26,28,29,30,34,36
63	K3XA	17,18,19,21,22,23,24,25,26,27,28,29,30,34,36
64	KB4CRT	2,17,18,19,21,22,23,24,26,28,29,34,36,37,39
65	JH7IFR	2,5,9,10,18,23,34,36,38,40
66	KØSQ	16,17,18,19,20,21,22,23,24,26,28,29,34
67	W3TC	17,18,19,21,22,23,24,26,28,29,30,34
68	IKØPEA	1,2,3,6,7,10,18,19,22,23,26,28,29,31,32
69	W4UDH	16,17,18,19,21,22,23,24,26,27,28,29,30,34,39
70	VR2XMT	2,5,6,9,18,23,40
71	EH9IB	1,2,3,6,10,17,18,19,23,27,28
72	K4MQG	17,18,19,21,22,23,24,25,26,28,29,30,34,39
73	JF6EZY	2,4,5,6,9,19,34,35,36,40
74	VE1YX	17,18,19,23,24,26,28,29,30,34
75	OK1VBN	1,2,3,6,7,10,12,18,19,22,23,24,32,34
76	UT7QF	1,2,3,6,10,12,13,19,24,26,30,31
77	K5NA	16,17,18,19,21,22,23,24,26,28,29,33,37,39
78	I4EAT	1,2,6,10,18,19,23,32
79	W3BTX	17,18,19,22,23,26,34,37,38
80	JH1HHC	2,5,7,9,18,34,35,37,40.
81	PY2RO	1,2,17,18,19,21,22,23,26,28,29,30,38,39,40
82	W4UM	18,19,21,22,23,24,26,27,28,29,34,37,39
83	I5KG	1,2,3,6,10,18,19,23,27,29,32
84	DF3CB	1,2,12,18,19,32
85	K4PI	17,18,19,21,22,23,24,26,28,29,30,34,37,38,39

Satellite Worked All Zones

No.	Callsign	Issue date	Zones Needed to have all 40 confirmed
1	KL7GRF	8 Mar. 93	None
2	VE6LQ	31 Mar. 93	None
3	KD6PY	1 June 93	None
4	OH5LK	23 June 93	None
5	AA6PJ	21 July 93	None
6	K7HDK	9 Sept. 93	None
7	W1NU	13 Oct. 93	None
8	DC8TS	29 Oct. 93	None
9	DG2SBW	12 Jan. 94	None
10	N4SU	20 Jan. 94	None
11	PAØAND	17 Feb. 94	None
12	VE3NPC	16 Mar. 94	None
13	WB4MLE	31 Mar. 94	None
14	OE3JIS	28 Feb. 95	None
15	JA1BLC	10 Apr. 97	None
16	F5ETM	30 Oct. 97	None
17	KE4SCY	15 Apr. 01	10,18,19,22,23, 24,26,27,28, 29,34,35,37,39
18	N6KK	15 Dec. 02	None
19	DL2AYK	7 May 03	2,10,19,29,34
20	N1HOQ	31 Jan. 04	10,13,18,19,23, 24,26,27,28,29, 33,34,36,37,39
21	AA6NP	12 Feb. 04	None
22	9V1XE	14 Aug. 04	2,5,7,8,9,10,12,13, 23,34,35,36,37,40
23	VR2XMT	01 May 06	2,5,8,9,10,11,12,13,23,34,40

CQ offers the Satellite Work All Zones award for stations who confirm a minimum of 25 zones worked via amateur radio satellite. In 2001 we "lowered the bar" from the original 40 zone requirement to encourage participation in this very difficult award. A Satellite WAZ certificate will indicate the number of zones that are confirmed when the applicant first applies for the award.

Endorsement stickers are not offered for this award. However, an embossed, gold seal will be issued to you when you finally confirm that last zone.

Rules and applications for the WAZ program may be obtained by sending a large SAE with two units of postage or an address label and $1.00 to the WAZ Award Manager: Floyd Gerald, N5FG, 17 Green Hollow Rd., Wiggins, MS 39577. The processing fee for all CQ awards is $6.00 for subscribers (please include your most recent *CQ* or *CQ VHF* mailing label or a copy) and $12.00 for nonsubscribers. Please make all checks payable to Floyd Gerald. Applicants sending QSL cards to a CQ Checkpoint or the Award Manager must include return postage. N5FG may also be reached via e-mail: <n5fg@cq-amateur-radio.com>.

*17 Green Hollow Rd., Wiggins, MS 39577; e-mail: <n5fg@cq-amateur-radio.com>

By Dr. H. Paul Shuch,* N6TX

DR. SETI'S STARSHIP

Searching For The Ultimate DX

Beckoning Beacons, Part 2

In last quarter's column, we discussed the challenges of calibrating amateur and professional SETI receiving stations (please see box with figures A and B). We concluded that a narrow-band signal from space, such as the S-band telemetry beacon aboard NASA's Pioneer 10 spacecraft, would be ideal for this purpose. Unfortunately, that particular beacon now is not only beyond the edge of our solar system, it is also beyond the range of reception by even Earth's most sensitive radio telescopes. In 2001, the nonprofit, grass roots SETI League sought to create a Pioneer 10 surrogate for use by radio astronomers around the world.

Radio amateurs have successfully been bouncing microwave signals off the rough lunar surface and detecting their echoes back on Earth since 1960. In 2001, SETI League members exploited the EME (Earth-Moon-Earth) path from W2ETI, their club station in New Jersey, for the benefit of radio astronomers worldwide. As seen in figure 1 and reported in *QST*[1], W2ETI's weak EME signal on 1296 MHz, its frequency precisely calibrated to atomic-clock accuracy, was first detected at the 20-watt level by the Arecibo Observatory in Puerto Rico, the world's largest radio telescope. The beacon subsequently was copied by a handful of radio amateurs possessing state-of-the-art stations, including a few reception reports logged during ARRL EME Contests, although its low power limited its utility, restricting reception to only the best equipped stations. Clearly, more power was needed to turn this facility into a truly universal calibration source.

*Executive Director Emeritus, The SETI League, Inc., <www.setileague.org>
e-mail: <n6tx@setileague.org>

More Power Needed

Over the next two years, the author and station trustee Richard Factor, WA2IKL, upgraded the W2ETI beacon to automatic tracking, remote monitoring, and unat-

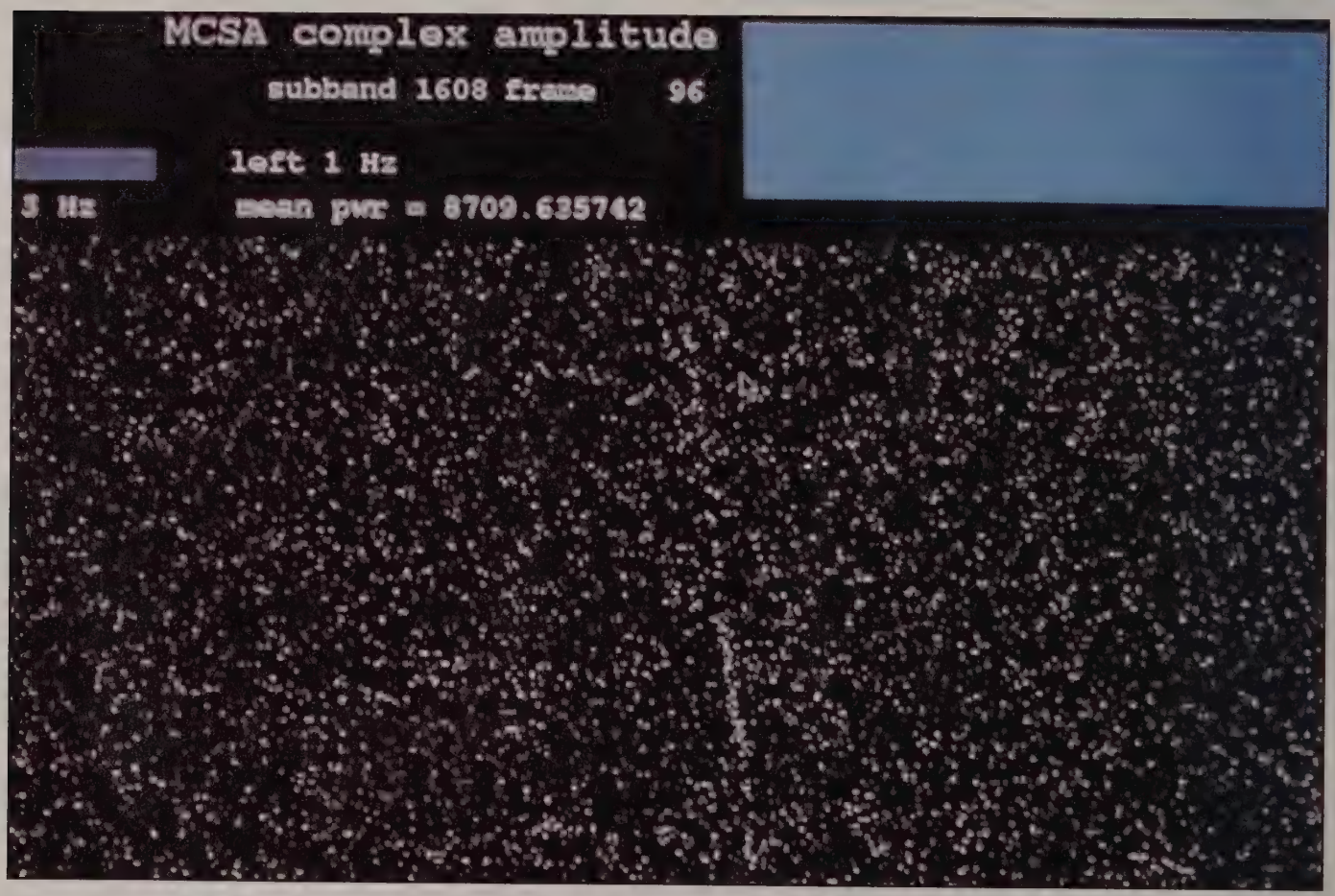

Figure 1. First Light of W2ETI QRP EME Beacon, as received at Arecibo by N6UDK, March 2001.

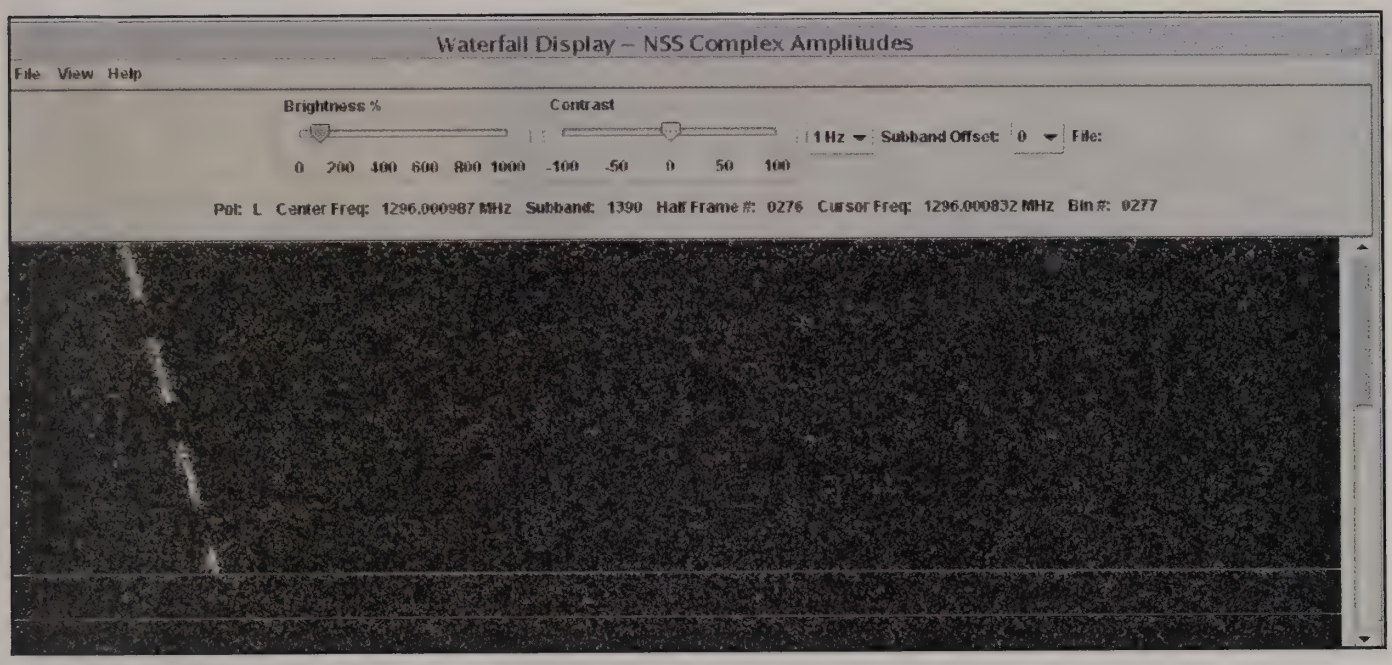

Figure 2. W2ETI's QRO CW signal received at Arecibo, March 2003.

tended QRO operation, with the addition of a solid-state power amplifier. Two years after "first light," calibration tests were repeated with Arecibo at the 100-watt level. The resulting CW signals, depicted in figure 2, were received clearly not only at Arecibo, but also by a host of radio amateurs, on dishes as small as 3 meters in diameter. At the 200-watt level the beacon transmitter was able to provide continuous signals, detectable by typical amateur radio telescopes around the world, any time the Moon was above the horizon at the station's New Jersey QTH.

Unfortunately, the reliability of the solid-state amplifier left

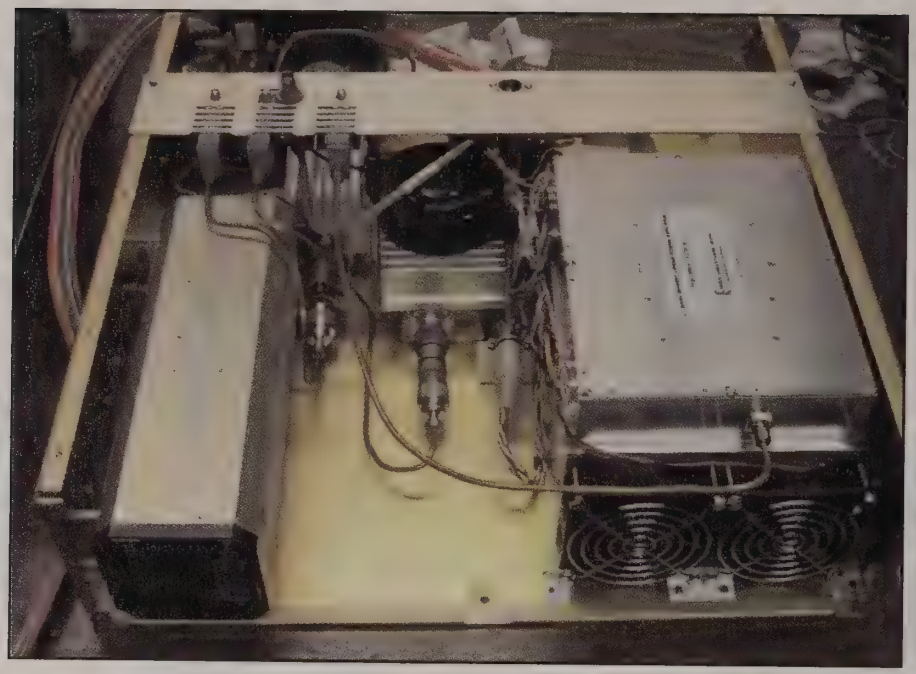

Figure 3. Kunhe MOSFET power amplifier installed in W2ETI EME beacon.

much to be desired. The amplifier incorporated 16 Mitsubishi M57762 RF modules in its final stage. These modules proved quite unreliable, especially when used continuously 12 hours per day. Having replaced several such modules over the period of a year (at a cost of roughly $100 U.S. each), we began studying alternatives to this particular solid-state power amplifier.

The SETI League was spared the expense of replacing more RF modules in the spring of 2004 by a lightning strike that damaged the fragile power amplifier beyond repair. Two years of total redesign followed. The beacon was returned to service in March 2006. The completely refurbished beacon gained a new 1/2-kw MOSFET power amplifier, the MKU 13500 A (see figure 3), ordered from Kunhe Electronics in Germany. WA2IKL has added a completely repackaged exciter, atomic and GPS frequency standards, new control computers and

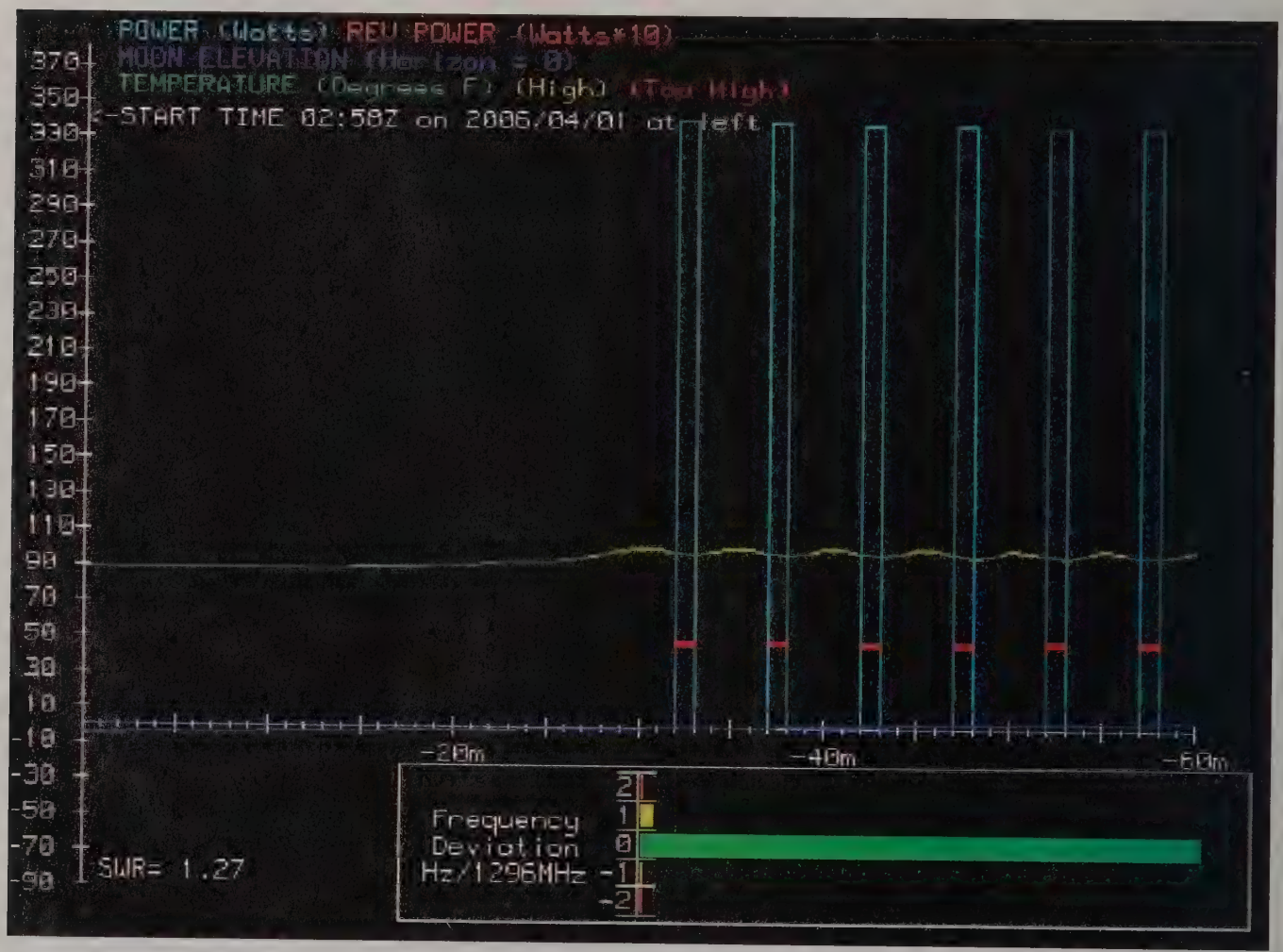

Figure 4. W2ETI Remote Telemetry displays beacon forward and reverse power, cooling air temperature, and frequency for the most recent hour, updated once per minute.

Correction

In Part 1 of "Beckoning Beacons," Dr. SETI's Starship, in the Fall 2008 issue of *CQ VHF*, we inadvertently published incorrect figures, figures that should have gone with Part 2 in this issue. The correct figures for Part 1 appear here as figures A and B. The figures that go with Part 2 are labeled 1 through 4 in this column. We apologize for any confusion.

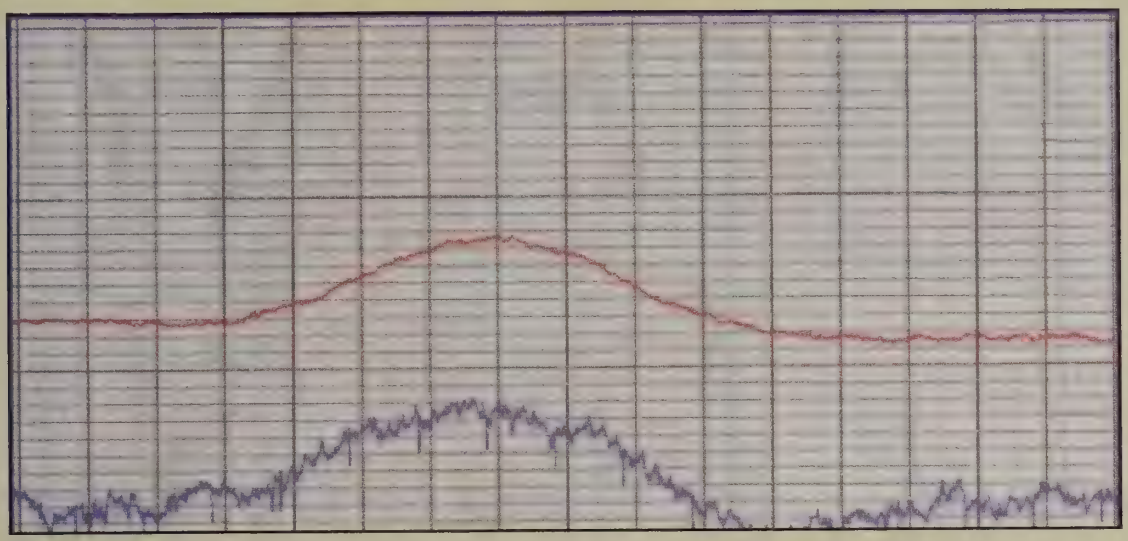

Figure A. Drift-scan sweep of Quasar 3C273 about 3 dB out of the noise.

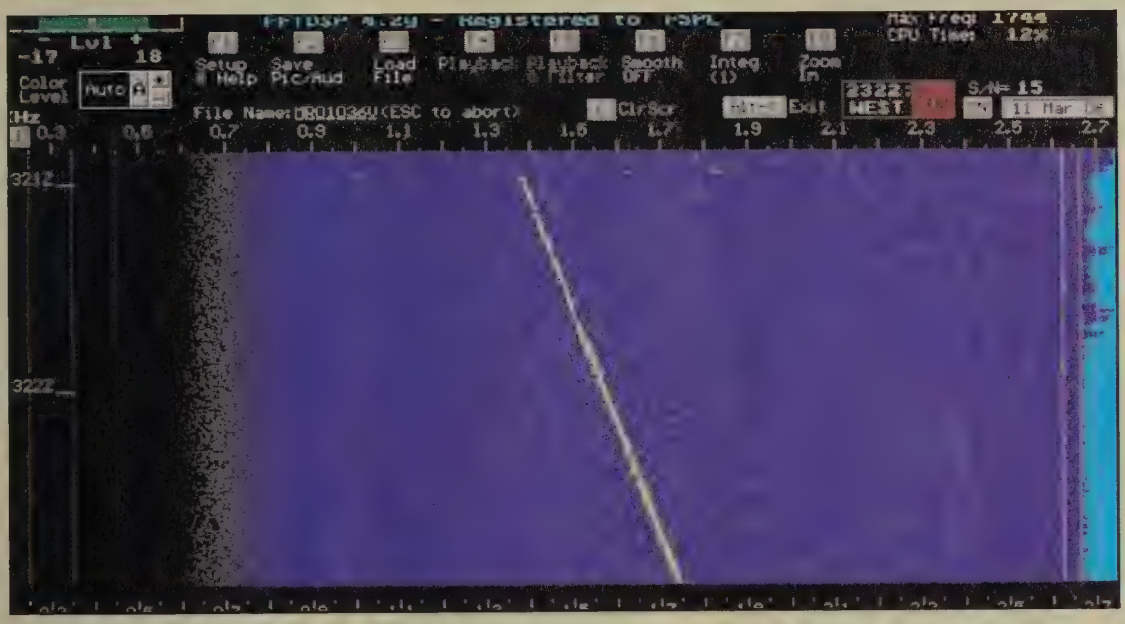

Figure B. Mars Reconnaissance Orbiter beacon received by F5PL from Martian orbit.

associated software, new power supplies, and a 3-kw UPS. The resulting beacon appears robust and reliable, offering amateur radio telescopes around the world precisely calibrated test signals emanating from a known spot in space.

An important feature of the renovated EME beacon is the use of remote monitoring via the internet. Any user can track transmitter power (forward and reflected), PA cooling air temperature, and frequency (in real time) by logging on to www.setileague.org/eme. As seen in figure 4, one hour of history, updating once per minute, is displayed.

The Next Step

Plans are under way to replace the existing quad helix antenna array with eight loop Yagis from Directive Systems of ME. The resulting improvement in gain promises to make the W2ETI 1296-MHz beacon accessible even to entry-level SETI, satellite, and EME stations.

Note

1. Shuch, H. Paul, N6TX, *2001,* "A Moonbounce Odyssey," *QST,* Vol. 85 (11): pp. 38–43, November 2001.

QUARTERLY CALENDAR OF EVENTS

Current Contests

The **European Worldwide EME Contest 2009**: Sponsored by DUBUS and REF. The EU WW EME contest is intended to encourage worldwide activity on moonbounce. Information for this contest is available at the following website: <http://www.marsport.org.uk/dubus/EUEMEcontest2009.pdf>.

Spring Sprints: These short-duration (usually four hours) VHF+ contests are held on various dates (for each band) during the months of April and May. Please check with the "VHF Plus" column in *CQ* magazine for a future announcement.

The **2 GHz and Up World Wide Club Contest**: Sponsored by the San Bernardino Microwave Society, this contest runs the second weekend of May. Rules are available at: <http://www.ham-radio.com/sbms>.

Conference and Convention

Southeast VHF Society: The 13th annual conference will be hosted in Charlotte, North Carolina, April 24–25, 2009. For information on registering for the conference, check the society's website: <http://www.svhfs.org/>.

Dayton HamVention®: The Dayton HamVention® will be held as usual at the Hara Arena in Dayton, Ohio, May 15–17. For more information, please see the website: <http:// www.hamvention.org>.

Calls for Papers

Calls for papers are issued in advance of forthcoming conferences either for presenters to be speakers, or for papers to be published in the conferences' *Proceedings,* or both. For more information, questions about format, media, hardcopy, e-mail, etc., please contact the person listed with the announcement. The following organizations and/or conference organizers have announced calls for papers for their forthcoming conferences:

Southeastern VHF Society Conference: Technical papers are solicited for the 13th annual Southeastern VHF Society Conference to be held in Charlotte, North Carolina on April 24–25. Papers and presentations are solicited on both the technical and operational aspects of VHF, UHF, and Microwave weak-signal amateur radio. In general, papers and presentations on non-weak-signal topics such as FM repeaters and packet will not be accepted, but exceptions may be made if the topic is related to weak signal. For example, a paper or presentation on the use of APRS to track rovers during contests would be considered.

The deadline for the submission of papers and presentations is March 2. All submissions should be in Microsoft Word (.doc) or alternatively Adobe Acrobat (.pdf) files. Pages are 8-1/2 by 11 inches with a 1-inch margin on the bottom and 3/4-inch margin on the other three sides. All text, drawings, photos, etc., should be black and white only (no color). Please indicate when you submit your paper or presentation if you plan to attend the conference and present there or if you are submitting just for publication. Papers and presentations will be published in the conference *Proceedings.* Send all questions, comments, and submissions to Program Chair Steve Kostro, N2CEI, at <svhfs2009@downeastmicrowave.com>.

Quarterly Calendar

The following is a list of important dates for EME enthusiasts:

February 1	Moderate EME conditions.
February 7	Moon perigee.
February 8	Very good EME conditions.
February 9	Full Moon.
February 9	Lunar eclipse.
February 15	Poor EME conditions.
February 16	Moon last quarter.
February 19	Moon apogee.
February 22	Poor EME conditions.
February 25	New Moon.
March 1	Moderate EME conditions.
March 4	Moon first quarter.
March 7	Moon perigee.
March 8	Excellent EME conditions.
March 11	Full Moon.
March 15	Poor EME conditions.
March 18	Moon last quarter.
March 19	Moon apogee.
March 20	Spring equinox.
March 22	Poor EME conditions.
March 26	New Moon.
March 29	Moderate EME conditions.
April 2	Moon perigee.
April 2	Moon first quarter.
April 5	Excellent EME conditions.
April 9	Full Moon.
April 12	Poor EME conditions.
April 16	Moon apogee.
April 17	Moon last quarter.
April 19	Poor EME conditions.
April 21	*Lyrids* meteor shower.
April 25	New Moon.
April 26	Moderate EME conditions.
April 28	Moon perigee.
May 1	Moon first quarter.
May 3	Very good EME conditions.
May 5	Eta Aquarids meteor shower.
May 9	Full Moon.
May 10	Very poor EME conditions.
May 14	Moon apogee.
May 17	Moon last quarter. Poor EME conditions.
May 24	New Moon. Moderate EME conditions.
May 26	Moon perigee.
May 31	Moon first quarter. Good EME conditions.
June 7	Full Moon. Very poor EME conditions.
June 10	Moon apogee.
June 14	Moderate EME conditions.
June 15	Moon last quarter.
June 21	Summer solstice. Moderate EME conditions.
June 22	New Moon.
June 23	Moon perigee.
June 28	Good EME conditions.
June 29	Moon first quarter.

—EME conditions courtesy W5LUU.

For more information about the conference go to: <http:// www.svhfs.org>.

Central States VHF Society Conference: Technical papers are solicited for the 43rd annual Central States VHF Society Conference to be held in Chicago, Illinois on July 23–26. Papers, presentations, and posters on all aspects of weak-signal VHF and above amateur radio are requested. You do not need to attend the conference, nor present your paper, to have it published in the *Proceedings.* Posters will be displayed during the two days of the conference. Non-weak signal topics, such as FM, repeaters, packet radio, etc., generally not considered acceptable. However, there are always exceptions. Please contact the person below if you have any questions about the suitability of a topic. Strong editorial preference will be given to those papers that are written and formatted specifically for publication, rather than as visual presentation aids.

Deadline for submissions: For the *Proceedings,* June 1; for presentations delivered at the conference, June 29; and for notifying them that you will have a poster to be displayed at the conference, also June 29. Please bring your poster with you on July 23/24. Contact information: Kermit Carlson, W9XA, via e-mail: <w9xa@yahoo.com>, or snail mail: Kermit Carlson, W9XA, 1150 McKee St., Batavia IL 60510. Submissions may be made via the following: electronic formats (preferred); via e-mail; uploaded to a website for subsequent downloading; on media (3.5" floppy, CD, USB stick/thumb drive). For more informationgo to: <http:// www.csvhfs.org>.

Meteor Showers

The α-*Centaurids* meteor shower is expected to peak on Feb. 7 at 2300 UTC. The γ-*Normids* shower is expected to peak on Mar. 13. Other Feb. and Mar. minor showers include the following and their possible radio peaks: *Capricornids/Sagittarids,* Feb. 1, 0900 UTC; and χ-*Capricornids,* Feb. 13, 1000 UTC.

The *Lyrids* meteor shower is active Apr. 16–25. It is predicted to peak around 1100 UTC on 22 Ap. This is a north-south shower, producing at its peak around 10–15 meteors per hour, with the possibility up to 90 per hour.

A minor shower and its predicted peak is *n-Puppids* (peak on Ap. 23, at 1600 UTC). Other Apr., May, and June minor showers include the following and their possible radio peaks: Apr. *Piscids*, Apr. 20, 0900 UTC; δ-*Piscids*, Apr. 24, 0900 UTC; ε-*Arietids*. May 9, 0800 UTC; May *Arietids,* May 16, 0900 UTC; and *o-Cetids,* May 20, 0800 UTC. June *Arietids,* June 7, 1100 UTC; *zeta-Perseids*, June 9, 1100 UTC; and β-*Taurids*, June 28, 1000 UTC.

For more information on the above meteor shower predictions please see Tomas Hood, NW7US's "VHF Propagation" column beginning on page 58, as well as visit the International Meteor Organization's website: <http://www.imo.net>.

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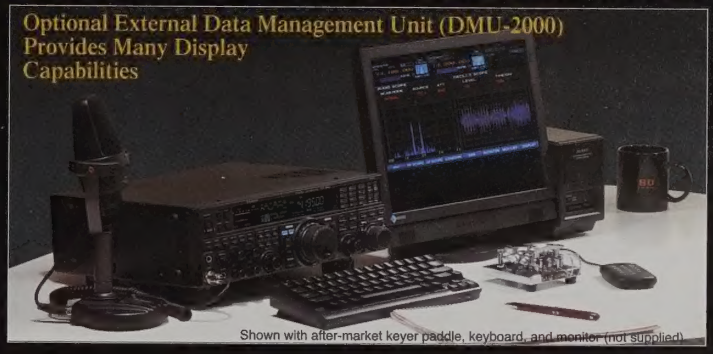

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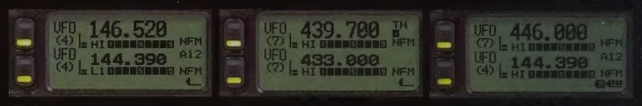

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FM 5 W/AM 1 W(50 MHz) Triple Band Handheld

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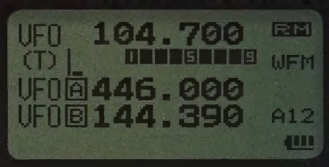

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- A large LCD backlit display in a compact case!
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*1 With optional accessories
*2 Cellular Blocked per FCC rule Part 15.121, may not receive 900 MHz Amateur band
*3 Assuming a duty cycle of 6-second transmit, 6-second receive, and 48-second standby (50 MHz 5 W)

* APRS® is a registered trademark of Bob Bruninga WB4APR.

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